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Volume 24 Number 6

BULLETIN
of the
AMERICAN ASSOCIATION OF
PETROLEUM GEOLOGISTS

JUNE, 1940

WILDCAT DRILLING IN 1939[1]

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Dallas, Texas

ABSTRACT

In 1939 wildcat drilling was not as intensive as it was in 1938, and fewer pools were discovered. During 1939, in the states covered by this report, 2,319 dry holes and 270 producers (oil and gas) were drilled as wildcats. The total footage drilled was 8,624,602 feet.

This paper reviews data on wildcat drilling for the fifth consecutive year.[3] The states covered are indicated in Figure 1.

Again, in compiling the data, we have tried to adhere to the definition of a wildcat as a hole drilled completely outside the known boundaries of pools already developed, and far enough from producing areas to be essentially a test of new possibilities. Such a hole would usually be at least 2 or 3 miles from production, but, where subsurface conditions may change in short distances and where predictions from the known may turn out to be greatly in error, a test hole may be regarded as a wildcat even if it is only $\frac{1}{2}$ or $\frac{3}{4}$ mile from production. This is notably true of salt domes. The term includes all true discoveries of new pools. Where a well in a developed pool has been deepened in search of *unknown* deeper possibilities, the footage *below* the old pay sand has been regarded as "wildcat footage"—dry footage if no new "pay" was found, and discovery footage if commercial oil or gas was encountered. As a matter of fact, however, the total of

[1] The writer wishes to express his gratitude to the following gentlemen through whose kindness and coöperation the data for this article were secured: A. P. Allison, L. J. Bateman, A. H. Bell, N. Burnett, G. E. Burton, R. J. Cullen, G. F. Fix, G. C. Gester, C. T. Jones, E. A. Koester, Chas. S. Lavington, A. M. Lloyd, D. J. Munroe, Geo. W. Myers, C. R. Nichols, C. H. Row, E. B. Wilson.

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[2] Chief geologist, Sun Oil Company.

[3] See this *Bulletin*, Vol. 21, pp. 1079–82; Vol. 22, pp. 645–48, 1231–35, 1236; and Vol. 23, pp. 789–94.

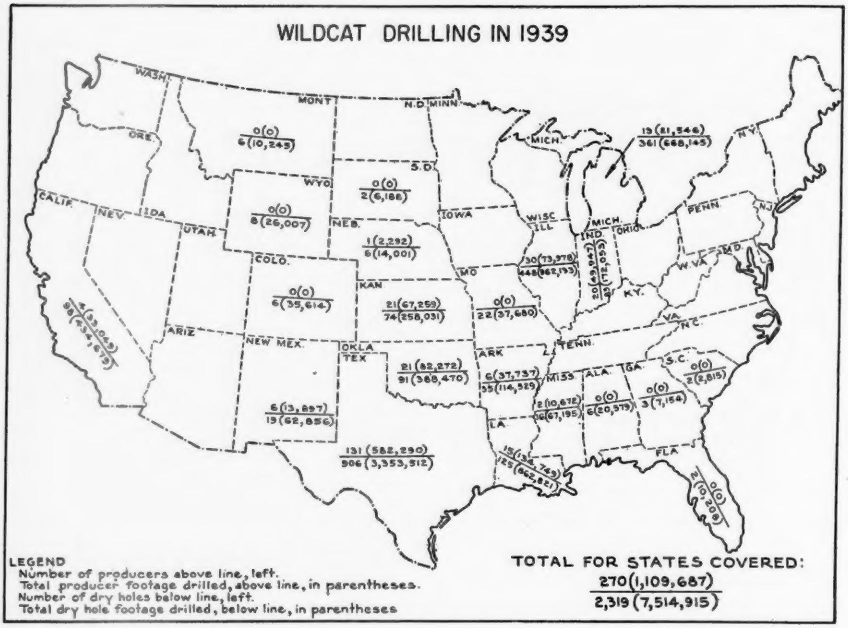

FIG. 1

FIG. 2

this class of drilled wildcat footage is a very small percentage of the whole.

On the maps (Figs. 1 and 2), numbers in parentheses indicate total footage drilled; figures preceding parentheses indicate the num-

ber of holes drilled; figures above the cross line are for producing wells, both oil and gas; and figures below the cross line are for dry holes. In the states covered in this review, as shown in Figure 1, and

TABLE I

NUMBER OF OIL WELLS, AND DRY HOLES DRILLED AS WILDCATS IN 1939

States	Oil		Gas		Dry		Total Number of Holes	Total Footage Drilled
	Number of Holes	Footage Drilled	Number of Holes	Footage Drilled	Number of Holes	Footage Drilled		
Alabama					6	20,579	6	20,579
Arkansas	5	36,119	1	1,618	35	114,529	41	152,266
California	4	33,049			98	434,679	102	467,728
Colorado					6	35,614	6	35,614
Florida					2	10,208	2	10,208
Georgia					3	7,154	3	7,154
Illinois	29	70,986	1	2,992	448	962.133	478	1,036,111
Indiana	17	47,822	3	2,124	83	172,053	103	221,999
Kansas	19	63,017	2	4,242	74	258,031	95	325,290
Louisiana	8	84,402	7	50,347	125	862,821	140	997.570
Michigan	12	19,521	1	2,025	361	668,145	374	689,691
Mississippi	2	10,672			16	67,195	18	77,867
Missouri					22	37,680	22	37,680
Montana					6	10,245	6	10,245
Nebraska	1	2,292			6	14,001	7	16,293
New Mexico	6	13,897			19	62,856	25	76,753
Oklahoma	17	64,386	4	17,886	91	388,470	112	470,742
So. Carolina					2	2,815	2	2,815
So. Dakota					2	6,188	2	6,188
Texas	104	467,277	27	115,013	906	3,353,512	1,036	3,935,802
Wyoming					8	26,007	8	26,007
	224	913,440	46	196,247	2,319	7,514,915	2,589	8,624,602

TABLE II

COMPARATIVE STATISTICS FOR GULF COASTAL PLAIN STATES, OMITTING NORTH-CENTRAL TEXAS AND PANHANDLE OF TEXAS

	Producers Drilled				Dry Holes Drilled				Total Number Wildcats Drilled	Average Depth of Hole (Feet)	Number of Dry-Hole Feet Drilled for Each Producer Foot
	Holes		Footage		Holes		Footage				
	Number	Per Cent	Feet	Per Cent	Number	Per Cent	Feet	Per Cent			
1935	78	7.32	354,834	9.7	987	92.68	3,415,296	90.3	1,065	3,540	9.63
1936	116	10.67	527,286	12.8	971	89.33	3,585,676	87.2	1,087	3,783	6.80
1937	138	12.1	765,690	15.7	1,002	87.9	4,096,990	84.3	1,140	4,090	5.35
1938	142	12.0	785,106	16.1	1,036	88.0	4,083,029	83.9	1,178	4,132	5.21
1939	134	11.5	681,696	14.4	1,029	88.5	4,173,955	85.6	1,163	4,175	6.12

listed in Table I, during 1939 a total of 8,624,602 feet was drilled in 2,589 holes, divided as follows.

270 producers..........	1,109,687 feet
2,319 dry holes...........	7,514,915 feet

This means that 10.43 per cent of the holes drilled, and 12.87 per cent of the footage drilled, was successful. The average depth of hole was 3,331 feet.

In the southern states district (Fig. 2), in 1939, a total of 5,281,014 feet was drilled in 1,274 holes, divided as follows.

161 producers..........	779,345 feet
1,113 dry holes..........	4,501,669 feet

In this area, then, 12.63 per cent of the holes drilled, and 14.75 per cent of the footage drilled, was successful. The average depth of hole was 4,145 feet.

For comparison with statistics furnished for the southern states in our earlier reports in which figures for the Panhandle of Texas and north-central Texas were not available, Table II is presented.

For comparison with statistics covering the southern states and including *all* of Texas, Table III is given.

TABLE III

COMPARATIVE STATISTICS FOR ALL STATES SHOWN IN FIGURE 2

	Producers Drilled				*Dry Holes Drilled*				*Total Number Wild-cats Drilled*	*Average Depth of Hole (Feet)*	*Number of Dry-Hole Feet Drilled for Each Producer Foot*
	Holes		*Footage*		*Holes*		*Footage*				
	Number	*Per Cent*	*Feet*	*Per Cent*	*Number*	*Per Cent*	*Feet*	*Per Cent*			
1938	200	13.6	984,262	17.4	1,271	86.4	4,667,402	82.6	1,471	3,842	4.74
1939	161	12.6	779,345	14.8	1,113	87.4	4,501,669	85.2	1,274	4,145	5.90

Selection of the location for a wildcat well may be based on geology (surface geology, subsurface geology, trend along known structural or stratigraphic conditions, local or regional, or shallow exploratory drilling); or it may be based on geophysics (exploration by seismograph, torsion balance, gravity meter, magnetometer, *et cetera*); or it may be based on some non-technical suggestion or requirement, such as "creekology," "hunch," "doodlebug," promotion, lease obligation, reported showing of oil or gas in holes previously drilled, *et cetera*. In many cases the reason for choosing the location can not be ascertained.

In Table IV are listed the reasons for drilling the wildcats in 1939, using the best information available from men familiar with such statistics, each in his own state or district. According to these figures, 217 wildcats drilled on technical advice (geology and/or geophysics) were successful (oil or gas), and 1,446 were dry; 43 holes located for non-technical reasons were producers, and 666 were dry; 10 producers and 207 dry holes were located for reasons unknown. These figures show that 13 per cent of the holes drilled on technical advice were producers as contrasted with 6 per cent successful in the case of the holes located without technical advice. Therefore, in 1939, as also in 1938,[4] locations based on technical recommendations were more than twice as successful as those drilled without such advice. In the southern states (Fig. 2), 9.5 per cent of the wildcats, located *without* technical advice, were producers, whereas 14.7 per cent of the holes located *on* technical advice were producers.

[4] *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 23 (1939), p. 793.

TABLE IV

BASIS FOR LOCATING WILDCATS DRILLED IN 1939

State	Geology		Geophysics*		Geology and Geophysics		Sundry Non-Technical		Unknown		Totals	
	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.	Dry	Prod.
Alabama							5		1		6	
Arkansas	21	1	7	2	5	3	1		1		35	6
California	51	2	13	2	8		17		9		98	4
Colorado	5		1								6	
Florida			1				1				2	
Georgia			1				2				3	
Illinois	59	6	89	17	3	1	232	6	65		448	30
Indiana	27	9	7	3			7	1	42	7	83	20
Kansas	27	11	33	1			13	6	1	3	74	21
Louisiana	42	4	63	11	4		9		7		125	15
Michigan	245	12	15				101	1			361	13
Mississippi	4		6			2	6				16	2
Missouri	13		5						4		22	
Montana	5				1						6	
Nebraska			2	1					4		6	1
New Mexico	11	4	8	2							19	6
Oklahoma	44	16	18	4			29	1			91	21
So. Carolina							1				2	
So. Dakota									2		2	
Texas	445	70	130	26	19	7	241	28	71		906	131
Wyoming	7		1								8	
Totals	1,006	135	400	69	40	13	666	43	207	10	2,319	270

* Geochemistry is here listed under geophysics.

As we have pointed out in previous reports of this kind, the relatively low percentage of wildcat successes contrasted with wildcat failures is a measure of the difficulties inherent in geological (including geophysical) interpretation; for geology is not, and never can be, a precise science. We do find, however, that the holes located on technical advice were from 1.5 to 2.2 times as successful as those drilled without such advice.

Wildcat drilling was not as intensively carried on in 1939 as in 1938, nor were there as many new pools discovered.

An interesting comparison may be made between the figures for 1937, 1938, and 1939.[5] In 1937, a total of 8,387,615 feet was drilled in 2,224 holes. In 1938, 8,860,484 feet were drilled in 2,638 holes, and in 1939, 8,624,602 feet were drilled in 2,589 holes. The average depth of the wildcat well of 1937 was 3,771 feet. In 1938, it was 3,358 feet, and in 1939, it was 3,331 feet.

In 1937 there were three times as many discovery wildcats drilled on technical advice as there were for non-technical reasons. In 1938 holes located on technical advice were from 2.2 to 3.2 times as successful as those drilled without such advice. In 1939, we find that this ratio lies between 1.5 and 2.2.

The decreasing average depth of wildcat wells in these three years, and the decreasing ratio of successful wildcats drilled for technical, as contrasted with non-technical, reasons, both call for an explanation.

Perusal of the figures given in Table I and on the accompanying map of the United States (Fig. 1), reveals the fact that, during this three-year period, drilling of wildcats in Illinois, Indiana, and Michigan greatly increased. In these three states, in 1937, 568,521 feet of hole were drilled in 248 wildcats; in 1938, 1,235,711 feet in 611 wildcats; and in 1939, 1,947,802 feet in 955 wildcats. The average depth of these holes in these three states, considered together, was 2,292 feet in 1937, 2,022 feet in 1938, and 2,039 feet in 1939. A relatively large proportion of these holes were located on other than technical reasons. In 1937, the wildcats drilled in these three states constituted 11 per cent of all the wildcats drilled in the part of the United States recorded in Fig. 1 and Table I. In 1938, this figure rose to 23 per cent; and in 1939, in these three states alone 36.8 per cent of the wildcats in the United States (Fig. 1) were drilled. In these facts, then, lies the explanation of the reduction in average depth of hole and the reduction in the percentage of successful holes located on technical advice, for the whole area covered by the present report.

[5] For 1937, see this *Bulletin*, Vol. 22, pp. 645–48, and pp. 1231–36. For 1938, see this *Bulletin*, Vol. 23, pp. 789–94.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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DEVELOPMENTS IN EASTERN INTERIOR BASIN, 1939 AND FIRST QUARTER OF 1940[1]

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ABSTRACT

Although Mississippian rocks continue to contribute the major part of the oil produced in this region, the outstanding new feature is the discovery and development of Devonian limestone wells in five pools, Sandoval, Salem, Bartelso, Centralia, and Tonti (in order of discovery). The saturated zone in the Devonian consists of dolomitic limestone with solution cavities, and probably fissures and joints. In the pools listed the top of Devonian limestone lies from 1,100 to 1,400 feet below the McClosky oölitic limestone (the lowest large producing zone in the Mississippian), and this interval probably increases to more than 2,000 feet in the deepest part of the basin. Initial productions of the new Devonian wells are exceptionally high for the area, some exceeding 10,000 barrels per day, thus indicating a high degree of permeability of the oil-bearing rock.

Thus far all the new areas of Devonian production are on structural closures indicated in Mississippian or Pennsylvanian key beds (or both) and furthermore are in areas of previous production from shallower strata. Whether or not there are structures affecting Devonian but not younger strata and of sufficient size to cause oil accumulation is not yet known.

INTRODUCTION

The Eastern Interior basin comprises an area of approximately 49,000 square miles of which 37,400 square miles or 76 per cent is in Illinois, 6,600 square miles or 14 per cent is in southwestern Indiana and 5,000 square miles or 10 per cent is in western Kentucky. The geographic and geologic setting of the Eastern Interior basin is illustrated in Figure 1. Although the major part of the recent oil activity in the basin has been in southern Illinois, there has also been increased activity in the adjacent parts of Indiana and Kentucky.

In this article recent developments are discussed briefly, especially the new Devonian limestone production in western Illinois. For comprehensive statistics on developments during 1939, the reader is referred to the forthcoming annual *Transactions* of the Petroleum Division of the American Institute of Mining and Metallurgical Engineers.

ILLINOIS

PRODUCTION

The history of oil production and development in Illinois may be read briefly in the bar chart of annual and monthly production (Fig.

[1] Read before the Association at Chicago, April 11, 1940. Manuscript received, April 29, 1940. Published with the permission of the chief, Illinois State Geological Survey, Urbana.

[2] Geologist and head, Oil and Gas Division, Illinois State Geological Survey.

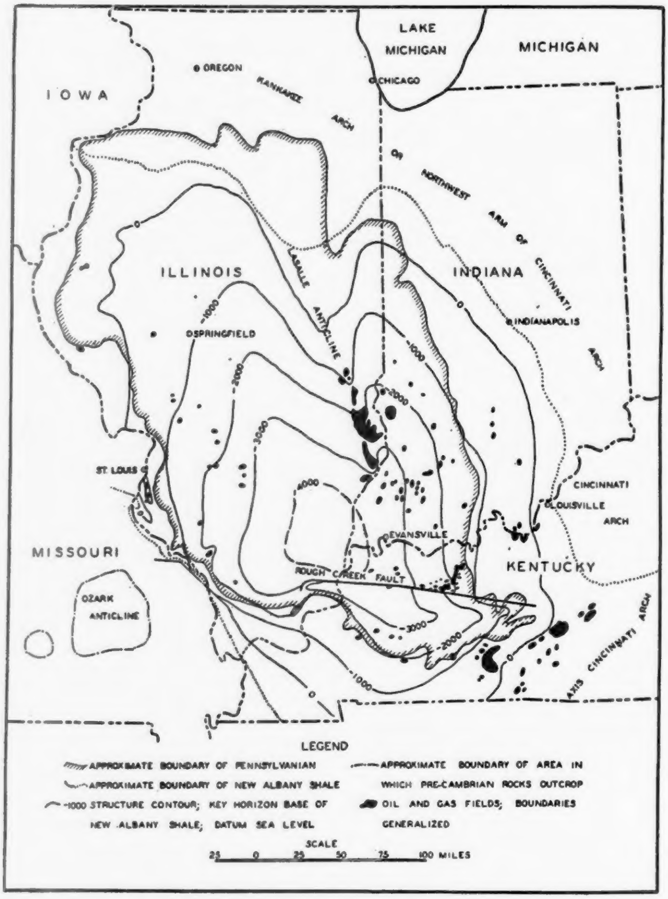

FIG. 1.—Map of Eastern Interior basin, showing principal tectonic features, oil and gas fields, and subsurface structure on base of New Albany shale. (From *Problems of Petroleum Geology*, Amer. Assoc. Petrol. Geol., 1934), p. 559.

2). The production of the state rose rapidly from 1905, reaching a peak of 33.7 million in 1908 when it ranked third in the United States. From 1910 to 1936—a 26-year period—it declined steadily to a little more than 4 million barrels per year when Illinois ranked 14th. Then the tide turned; in 1937 production rose to 7.4 million barrels, in 1938 to 24 million barrels, in 1939 to 94 million barrels, the state's rank

rising to 11th in 1937, 8th in 1938, and 4th in 1939. The 1939 production was almost 3 times the peak in 1908.

During 1939 the monthly production rose from 4,446,000 barrels in January to 10,443,000 barrels in September after which it remained almost constant at a level between 10 and 10.5 million barrels for 4 months. Again in January, 1940, production began to rise rapidly,

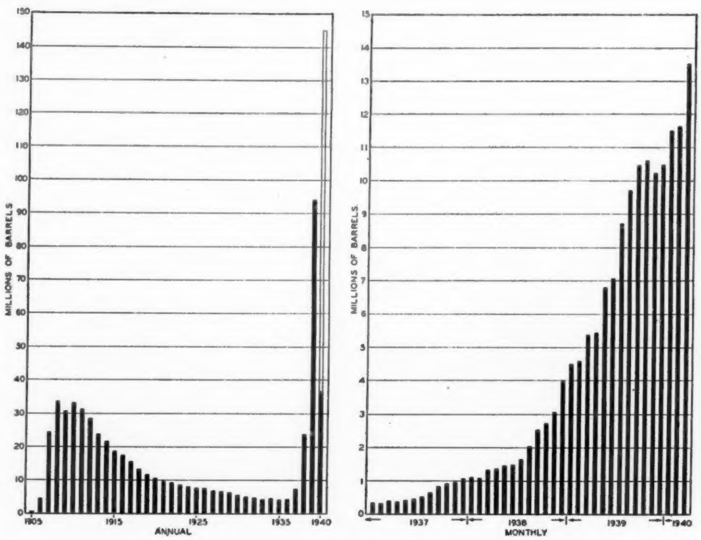

FIG. 2.—Crude-oil production in Illinois: annual, 1905–1940; and monthly, January, 1937–March, 1940.

reaching approximately 13.5 million barrels in March, 1940. The daily average during March was approximately 433,000 barrels. If production during the rest of the year continues at the average rate established in the first quarter, the 1940 production will be approximately 145 million barrels.

Oil and gas fields in Illinois as of January 1, 1940, are shown in Figure 3. Those discovered in 1939 are shown in solid black, those discovered in 1937 and 1938 are in outline, and those discovered prior to 1937 are in stippled pattern. Attention is called to the Salem pool (No. 24) which is responsible for more than half of the state's daily production, and to the Louden pool (No. 11) which is the largest in

OIL AND GAS FIELDS OF ILLINOIS

Fields prior to 1937; abandoned.

Discoveries in 1937 and 1938; abandoned.

Discoveries in 1939; abandoned.

NEW FIELDS

1. Bond: Sorento
2. Clay: Flora
3. Iola*
4. Clay, Wayne: Clay City
5. Clinton: Hoffman*
6. Clinton, Marion: Centralia
7. Coles: Hutton*
8. Mattoon*
9. Edwards: Cowling*
10. Edwards, White: Grayville*
11. Fayette: Louden-Beecher City
12. St. James
13. Franklin: Whittington*
14. Gallatin: Junction*
15. Jefferson: Cravat*
16. Dix
17. Elk Prairie
18. Ina
19. Marcoe
20. Roaches
21. Lawrence: Russellville gas
22. Macoupin: Plainview gas
23. Marion: Patoka
24. Salem-Lake Centralia
25. Tonti*
26. Marion, Clinton: Fairman*
27. Richland: Dundas*
28. Noble
29. Olney
30. Schnell
31. Shelby: Stewardson*
32. Wabash: East Keensburg*
33. Griffin*
34. Keensburg*
35. Mt. Carmel*
36. Washington: Cordes*
37. Dubois*
38. Wayne: Barn Hill*
39. Boyleston
40. Cisne
41. Enterprise*
42. Goldengate*
43. Leech Twp.
44. Mt. Erie
45. North Aden
46. Rinard
47. South Mt. Erie*
48. Wayne, Hamilton: Aden
49. White: Calvin*
50. Mill Shoals*
51. New Harmony*
52. Phillipstown*
53. Stokes*
54. Storms*

*Discoveries and extensions in 1939

JANUARY 1, 1940

ILLINOIS STATE GEOLOGICAL SURVEY

FIG. 3.—Oil and gas fields of Illinois, January 1, 1940.

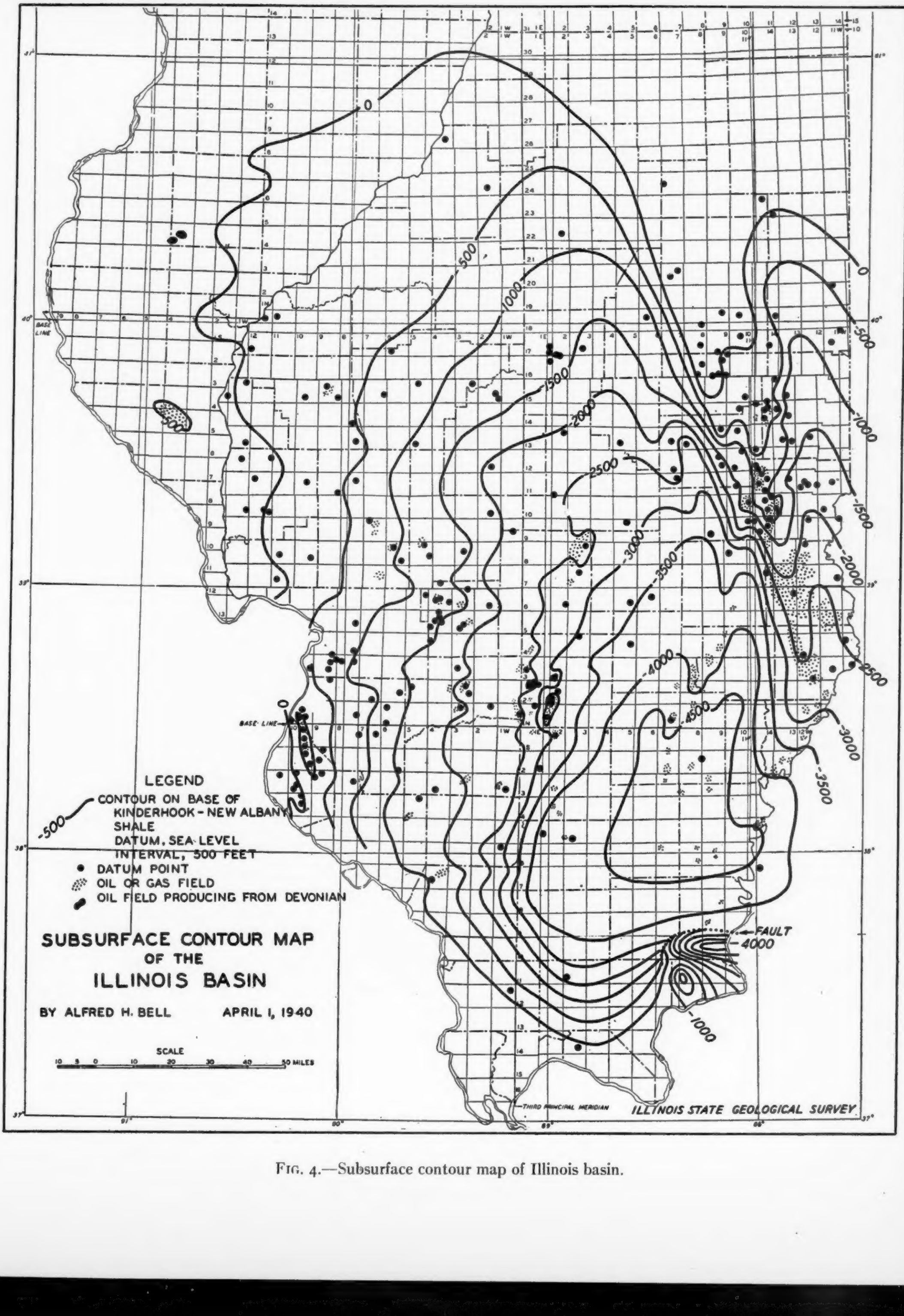

FIG. 4.—Subsurface contour map of Illinois basin.

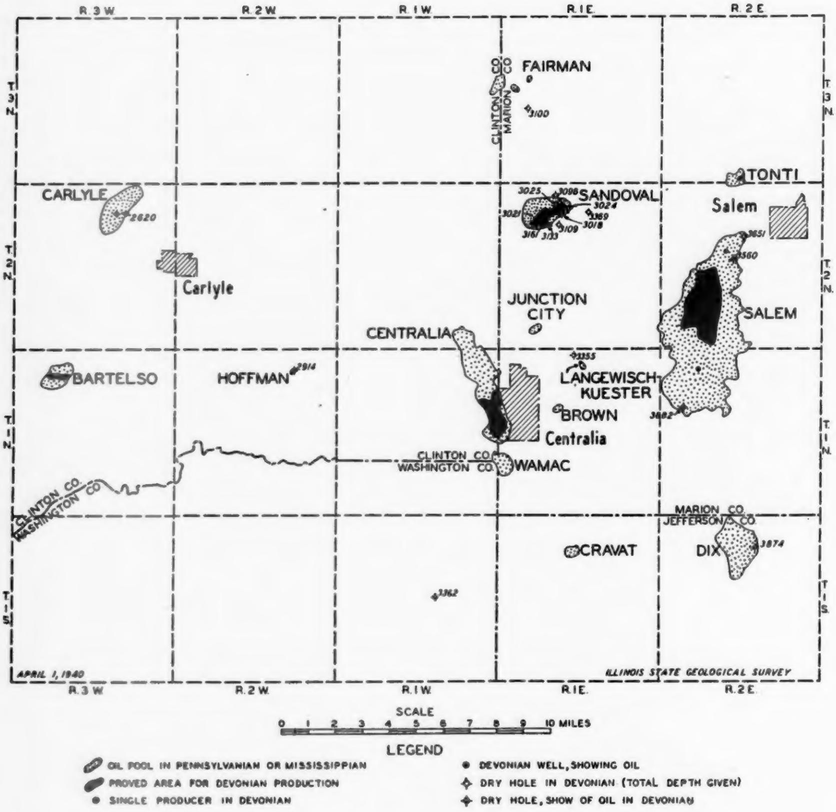

FIG. 5.—Map of new Devonian oil pools in Illinois.

area of the new pools. Among 1939 discoveries the following yielded the most oil to the end of the year.

Tonti (No. 25)	900,000 barrels
Keensburg (No. 34)	780,000 barrels
Barn Hill (No. 38)	600,000 barrels
Cordes (No. 36)	470,000 barrels

STRUCTURE

The subsurface features of the Illinois part of the Eastern Interior basin are shown in somewhat greater detail in Figure 4 than in Figure 1. The contoured horizon is the same, the base of the Kinderhook-New Albany shale, but the scale is larger and the contour interval is 500 feet instead of 1,000 feet. The predominant structural features are the LaSalle anticline which is shown extending more than 150 miles through the eastern part of the mapped area, and the Shawneetown-Rough Creek fault in the southeast corner, with the associated Eagle Valley syncline and Hicks dome south of it. Elsewhere, three structural closures may be noted, a minus 3,000-foot contour around the Salem anticline, Marion County, a zero (sea-level) contour around the Waterloo-Dupo anticline, St. Clair and Monroe counties, and a plus 500-foot contour around the Pittsfield-Hadley anticline in Pike County.

Where datum points are closely spaced there are many bends in the contours representing minor flexures. When more data become available from wells drilled to the Devonian, the presence of additional minor flexures will doubtless be revealed and revisions will be necessary. This is believed to be especially true of the southern part of the deep-basin area where many pools now producing from Mississippian strata are likely to be tested to the Devonian or deeper.

DEVONIAN PRODUCTION

The location of five new Devonian oil pools in the western part of the Illinois basin is shown in Figure 5. It will be noted that the areas of proved Devonian production are all more restricted than the areas of Mississippian production in which they occur. Data on these pools are tabulated here.

Since December, 1938, when oil production from Devonian limestone was discovered in the old Sandoval pool in Marion County, approximately 12,600,000 barrels of oil have been produced from about 276 wells in the 5 pools. Of this, approximately 11,800,000 barrels, or about 95 per cent of the total, was produced during 4 months (December 1, 1939, to March 31, 1940). Slightly more than 1 million barrels was produced from 23 Devonian wells in the Sandoval

Data on Five New Devonian Oil Pools in Western Part of Illinois Basin—April 2, 1940

Field	*County*	*Date Discovered*	*Age in Months (Approx.)*	*Producing Wells*	*Dry Holes**	*Drilling Wells*
Sandoval	Marion	12-20-38	15	23	8	4
Salem	Marion	11-21-39	4	182	3	86
Bartelso	Clinton	12- 5-39	4	3	0	5
Centralia	Clinton and Marion	12-31-39	3	66	0	86
Tonti	Marion	1-23-40	2	2	0	0
				276	11	181

* Within 1 mile of production.

pool in 15 months, a little more than 11 million barrels was produced from 182 wells in the Salem pool in 4 months, and approximately 425,000 barrels from 66 wells in the Centralia pool in 3 months.

All of the new Devonian oil pools are in areas of structural closure as shown on either Pennsylvanian or Mississippian key beds or both, and furthermore, they are in areas of previous production from shallower sands. Although boundaries of the Devonian production are not yet well defined (except in part of the Sandoval pool), present indications are that the productive areas are smaller than those in Mississippian sands and that they are confined to the upper parts of the structures. In this respect the new Devonian pools resemble the old Martinsville pool in Clark County where the Devonian limestone is productive, and the Westfield pool where the "Trenton" limestone is productive high on the crests of large domes.

Subsurface contour maps of the Salem field on the top of the Bethel (Benoist sand) and on the top of the Devonian limestone are shown in Figure 6. The position of the anticlinal axis, where known, appears to be almost exactly the same for the two horizons although they are separated by an interval of about 1,650 feet. The rate of dip seems to be nearly the same for the two horizons where they can be compared on the east limb of the anticline, the dip of the Devonian being only slightly greater. Drilling data are not yet available which would permit a comparison of the dips for the two horizons on the west limb of the anticline.

The presence of two Devonian dry holes within the limits of Mississippian production and a third well which is a small producer and is making some water give some indication of the more restricted boundary for the Devonian production. The latter well, near the center of Section 16, is at a point about ½ mile west of the eastern bound-

ary of Mississippian production. Here the top of the Devonian limestone has an approximate elevation of −2,934 feet. If we assume that the boundary of the Devonian production follows the contours, the total productive area for Devonian would be approximately 5,000 acres. This compares with approximately 8,870 acres for the Benoist and McClosky.

Although the data are not at hand for the construction of production decline curves for Devonian wells in the Salem pool, indications

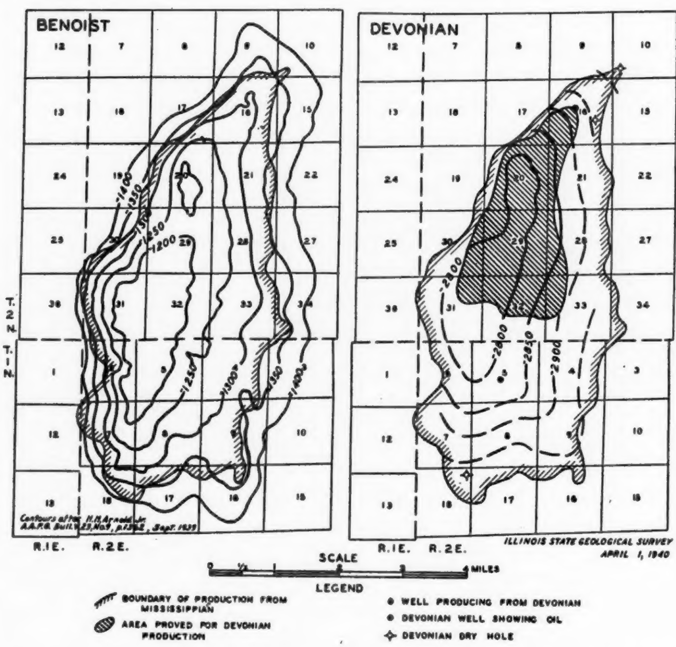

Fig. 6.—Subsurface contour maps of Salem field on Bethel formation (Benoist sand) and on Devonian limestone.

are that early declines are rapid. The high initial productions for some of the wells indicate a high degree of permeability in the reservoir rock. For the week ending April 2, average initial production for 12 wells was 1,775 barrels as compared with approximately 3,200 barrels for the first 14 wells in the pool (to January 16, 1940). This decline in initial productions of new wells in the short period of 3 months suggests that the reservoir energy is being rapidly depleted.

INDIANA

The following information regarding oil and gas developments in southwestern Indiana was provided by Ralph Esarey, State geologist, and G. F. Fix, State gas supervisor, Indianapolis, Indiana.

During 1939 Indiana experienced a great increase in prospecting and drilling for oil and gas. Major activity, as during the preceding year, was in the southwestern part of the state, the Indiana portion of the Eastern Interior Coal basin. An increasing interest was evident during the year, however, in the entire state, chiefly in northern Indiana, on the south flanks of the Michigan basin, and in the old Trenton field of east-central Indiana. In the latter area several tests to deeper parts of the Trenton and to the underlying St. Peter sandstone were completed. Results have been discouraging, however.

There were 377 wells completed in Indiana during 1939 and 77 others were in various stages of drilling at the close of the year. Of the 377 completed, 255 were classed as field locations and 122 as wildcats or semi-wildcats. The field wells were divided as follows: 156 oil wells, 39 gas wells, and 60 dry holes. Wildcats: 98 dry holes, 19 oil wells, and 5 gas wells (wildcat oil and gas wells include deeper production in oil fields and field extensions as well as new field discoveries). During 1939, 218 more wells were completed than during 1938.

Outstanding developments for 1939 include the discovery of several new oil and gas fields. In the Griffin field, discovered during the closing days of 1938, 83 wells were drilled of which 80 were productive. The Superior Oil Company (California) opened the New Harmony pool on Ribeyre Island, western Posey County, with their New Harmony Realty Company well No. 1, and 17 other oil wells and 1 dry hole were drilled on the Indiana side of this field during the year. Damron Brothers discovered the new Rockport gas field in Spencer County. Production is from the Palestine sandstone (upper Chester) at depths of 890–900 feet. The initial production of wells varies from 2.5 million to 21 million cubic feet per day. Deeper production or field extensions added new production to several other fields during the year. In addition, several "singles" were scattered over the southwestern counties—areas in which only one productive well had been completed at the close of the year, so that it was not possible to determine whether or not a new field of any proportions had been discovered.

Pipeline proration, limiting wells to $\frac{2}{3}$ their potential, continued in the older fields in the state. Many of these older fields failed to produce even their last year's allowable. Total oil production was 1,729,564

barrels; total gas production was 871,586 million cubic feet. The only new gas production of any consequence (Rockport, potential between 75 million and 100 million cubic feet per day) had no pipeline connections until after the end of the year. Consequently, no gas was sold from this field during 1939.

Leasing activity has declined considerably in southwestern Indiana, since most of the desirable acreage is now under lease. Many operators are now interested in other parts of the state and are leasing accordingly. It is probable that activity during 1940 will be as great as, or greater than, during 1939, since many operators, both independent and major companies, hold large blocks of leases which have not been tested.

KENTUCKY

The following information regarding oil and gas developments in western Kentucky was provided by D. J. Jones, State geologist, Lexington, Kentucky.

There have been 495 tests drilled in western Kentucky during the year of 1939 and the first quarter of 1940. Of these tests, 215 were oil wells, 264 were dry holes, and 16 were gas wells; 136 were wildcat tests 20 of which were productive.

Oil is being produced from sandstones and limestones ranging from the basal Pottsville to the McClosky sand of the Ste. Genevieve limestone.

Production is commonly found on domes and plunging anticlines. In many places it is governed by the lenticularity of the producing formation, as well as by the variable conditions of porosity.

Wells in various parts of the productive area range in depth from 150 to approximately 2,500 feet. Initial production in western Kentucky ranges up to 1,500 barrels per day. Total production for 1939 and the first quarter of 1940 for this area was 3,692,516 barrels. A large percentage of this oil was produced from Daviess, Hancock, Henderson, and McLean counties.

Total accumulated production for western Kentucky on April 1, 1940, is 39,634,367 barrels as compared with approximately 175 million barrels for the entire state.

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DEEP-SAND DEVELOPMENTS IN APPALACHIAN REGION DURING 1939[1]

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Pittsburgh, Pennsylvania

ABSTRACT

Results of developments for "deep"-sand oil and gas in the Appalachian region during the past year have been discouraging. Two Oriskany sand gas pools were discovered in southern New York, and two in northern Pennsylvania, but none was of any great extent. Depletion in this region has been much more rapid than the addition to reserves through new discoveries. Two new Oriskany gas pools were discovered in Jackson County, West Virginia, but neither has been tested sufficiently to indicate its extent. In Kanawha and Jackson counties, West Virginia, the Elk-Poca Oriskany field was extended north and northwest to embrace approximately ten thousand (10,000) additional acres with a possible increase in reserve of 60,000,000 thousand cubic feet.

INTRODUCTION

This discussion is not concerned with development of the "shallow sands" in the region; rather only those of the Oriskany sand, the chief source of interest to eastern gas operators during the past 10 years, are considered (Fig. 1).

NEW YORK

In the Oriskany sand area of southern New York, which includes Allegany, Steuben, Chemung, Schuyler, and Tompkins counties, fifty-six wells were completed during the year. Of these, nineteen were gas wells with a combined daily open flow of 81,000 thousand cubic feet, while thirty-seven were dry holes. There were twelve active wells at the end of the year. Two new pools were discovered, one in Tompkins County, about 4 miles south of Ithaca, and the other near Jasper, in Steuben County. The former was a disappointment, and already has been abandoned. The latter also seems to be limited to a very small area and probably has not added materially to the reserves of the section.

PENNSYLVANIA

In Tioga, Potter, and McKean counties of northern Pennsylvania, fifty-four wells were completed, of which twenty-seven were dry holes and twenty-seven were gas wells having a combined daily open flow of 344,250 thousand cubic feet. Twelve wells were drilling at the end of the year.

Two new pools were discovered in Potter County. Of these, the

[1] Presented before the Association at Chicago, April 11, 1940. Manuscript received, February 15, 1940.

[2] Chief engineer and geologist, Carnegie Natural Gas Company.

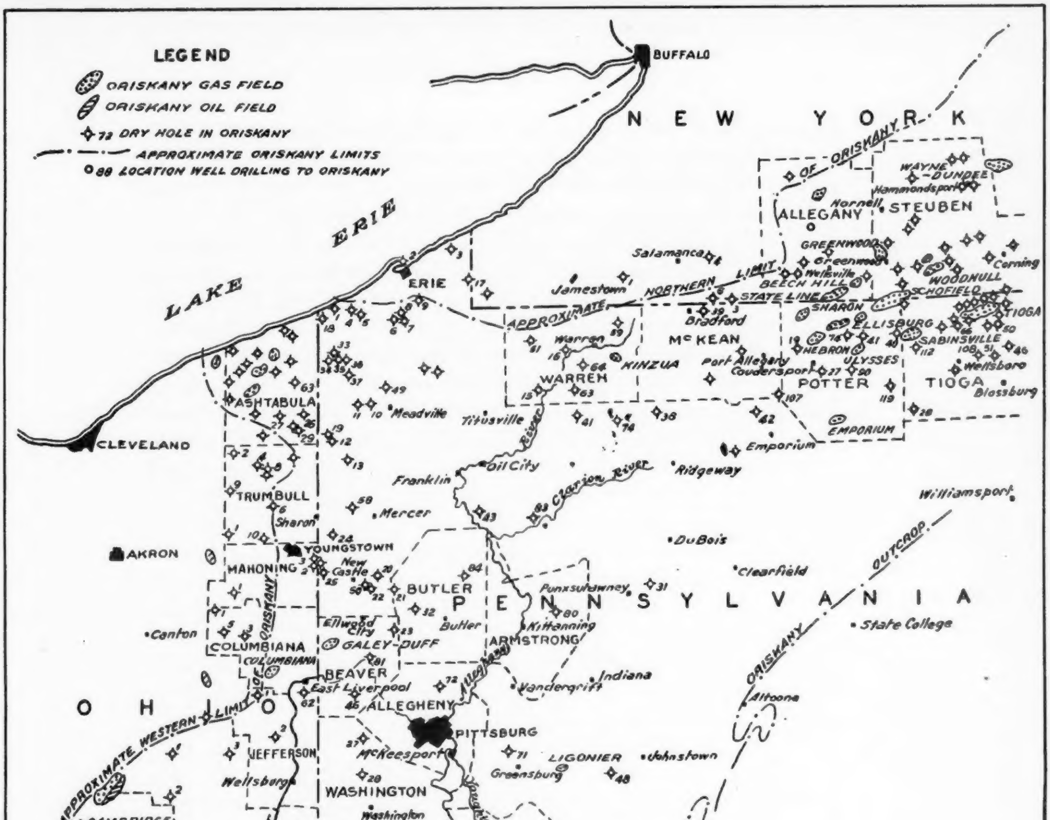
LEGEND
ORISKANY GAS FIELD
ORISKANY OIL FIELD
72 DRY HOLE IN ORISKANY
APPROXIMATE ORISKANY LIMITS
88 LOCATION WELL DRILLING TO ORISKANY
LAKE ERIE
BUFFALO
NEW YORK
OHIO
PENNSYLVANIA
MARYLAND
WEST VIRGINIA
VIRGINIA
CLEVELAND
AKRON
YOUNGSTOWN
PITTSBURG
ERIE
ASHTABULA
TRUMBULL
MAHONING
COLUMBIANA
JEFFERSON
BUTLER
BEAVER
ALLEGHENY
ARMSTRONG
WASHINGTON
GREENE
FAYETTE
WARREN
Mc KEAN
POTTER
TIOGA
ALLEGANY
STEUBEN
GARRETT
WOOD
WIRT
RIPLEY
JACKSON
ROANE
KANAWHA
CHARLESTON
CAMBRIDGE
GUERNSEY
ELK-POCA
CAMPBELLS CREEK
SUMMIT
GALEY-DUFF
APPROXIMATE WESTERN LIMIT
APPROXIMATE NORTHERN LIMIT OF ORISKANY
ORISKANY OUTCROP
APPROXIMATE EASTERN
MAP
OF THE
APPALACHIAN AREA
SHOWING
ORISKANY SAND DEVELOPMENT
SCALE
16 8 0 16 32 MILES

FIG. 1

Sharon pool, in which sixteen gas wells with a combined open flow of 279,250 thousand cubic feet daily were completed, was the most important. However, it is believed that this pool has been fairly well defined and that it is confined to a very limited area. The Ulysses pool near Gold is the latest discovery, two wells with a combined open flow of 850 thousand cubic feet daily having been completed. Six wells are now drilling in this area and these should define extent of the pool.

The search for gas in the Oriskany sand in the southwestern part of Pennsylvania has continued throughout the year, but results have not been encouraging. One dry hole was completed in each of Clarion, Butler, Armstrong, and Fayette counties, while two dry holes were drilled in Beaver County. In the Summit pool on the Chestnut Ridge anticline in Fayette County, two gas wells were completed, one producing from the Huntersville chert above the Oriskany sand, and the other from both the Huntersville and the Oriskany. The combined open flow of these two wells was 3,226 thousand cubic feet daily. Previously four other wells producing from the Huntersville chert with a combined open flow of 11,600 thousand cubic feet were completed in this pool. At present, two wells are drilling.

A very important test is now being drilled east of the Summit pool, which is located on the Laurel Ridge anticline, northeast of Ohiopyle in Fayette County.

MARYLAND

A test is now drilling on the Accident anticline, an extension of the Negro Mountain anticline of Pennsylvania, at Accident, Maryland. A commercial gas well in the deeper formations at either this location or the location near Ohiopyle would point to almost unlimited possibilities for deep sand gas on the highly folded structures of West Virginia, Maryland, and Pennsylvania, in the region east of the present-defined productive area.

OHIO

Only two wildcat tests were drilled in the Oriskany sand area of eastern Ohio during the year, both of which were unproductive. One was located in Mahoning and the other in Harrison County.

WEST VIRGINIA

Wildcat prospecting in the Oriskany sand area of West Virginia was limited to Jackson and Pleasants counties. One dry hole was drilled on the Volcano anticline in Pleasants County, while five tests were drilled in Jackson County outside of the Elk-Poca field. Two of

these tests were dry holes and three were gas wells having a combined initial daily open flow of 3,228 thousand cubic feet. Two of the gas wells opened new pools, indicating many possibilities of production being found between the Elk-Poca field and the Oriskany sand field at Cambridge, Ohio.

Sixty-eight wells were completed in the Elk-Poca field. Fifty-eight of these were in Kanawha County, fifty-six being gas wells with a combined open flow of 346,610 thousand cubic feet daily and two dry holes. Ten were in Jackson County, all of which were productive, with a combined daily open flow of 90,942 thousand cubic feet. Twenty-two wells are now drilling in Kanawha County, eleven in Jackson County, and one in Wood County.

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DEVELOPMENTS IN MICHIGAN DURING 1939[1]

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ABSTRACT

During 1939 the limelight was taken in Michigan by three fields, Bloomingdale (Van Buren County), Temple (Clare County), and Walker or Grand Rapids (Kent County). Before the beginning of the year Bloomingdale had eclipsed Buckeye (Gladwin County) and led until July, when it was overtaken in production by the Temple field. By November the Walker field near Grand Rapids, which had only one active drilling well at the start of the year, reached an output which was in excess of any other field. This was the first year since the Muskegon "boom" in 1929 that western Michigan fields had taken foremost position.

The year established a definite Traverse producing area of regional magnitude in the southwest part of the state and set up a rivalry for supremacy between the shallow fields of southwestern Michigan and the deeper producing areas of the "Basin."

The other active fields of the year were Wise (Isabella County); New Salem and East Salem extension (Allegan County); South Columbia or Bear Lake (Van Buren County); East Columbia and Berlamont (Van Buren County); Dundee or Deerfield (Monroe County); and Wisner (Tuscola County).

There was active drilling for "Michigan stray" gas southeast of the Temple field and for Berea gas in the Clayton field (Arenac County). Pipeline construction of some magnitude followed both of these areas of drilling activity. A line was built from Amble (Winfield gas area, Montcalm County) to Greenville and also from the Walker field to the trunk line of the West Michigan Consumers, Inc. at Ravenna. A new shallow (Berea?) gas area was discovered in Wright and Polkton townships, Ottawa County.

The oil discoveries of the year were seemingly of minor importance in making large new reserves available. These were Hopkins (Allegan County), Bangor (Van Buren County), Zeeland (Ottawa County), Porter (Van Buren County), Silver Creek (Cass County), South Overisel (Allegan County), and Hope (Barry County). Wildcatting was much more extensive in southwestern Michigan than in the "Basin," which explains the localization of the discoveries.

Outstanding during 1939 was the passage of the new conservation statute which resulted in regulations covering proration and well-spacing programs. Crude-oil price strengthened gradually and by the end of the year it had reached nearly to market parity with other states.

Increased activity took place in the use of geophysics and soil analysis for exploration, largely with negative results. Test-well drilling for structure was carried on in several areas where it was reported to have been successful. However, regional subsurface interpretations from scattered wildcats led to most of the discoveries in the past year.

Deep tests to the Sylvania (middle Monroe) were carried on in the Porter, Buckeye, and Bloomingdale fields, and on the Kawkawlin structure, but only small amounts of oil were found.

No major oil pipelines were built but several gathering systems and feeders to railheads were laid to service the Wise field, and the fields of southwestern Michigan. Five small refineries were constructed: two at Grand Rapids, two at Bloomingdale, and one at Kalamazoo. The older refineries with cracking and reforming units so increased output that retail gasoline prices took a sharp drop in western Michigan, and particularly in the Grand Rapids marketing area.

INTRODUCTION

The leading fields in Michigan during 1939 were Bloomingdale (Van Buren County), Temple (Clare County), and Grand Rapids

[1] Read before the Association at Chicago, April 11, 1940. Manuscript received, April 10, 1940.

[2] Consulting geologist, 901 North Otillia Street, SE.

(including Walker and Wyoming in Kent County and Tallmadge in Ottawa County). Of these fields, two were in southwestern Michigan and one was in central Michigan or in the parlance which has become familiar in this area two were "Southwest" and one was in the "Basin." The shift of concentrated drilling activity from the region around Mount Pleasant to a district south of Grand Rapids and west of Kalamazoo set up a rivalry for supremacy between the shallow Traverse fields of the southwestern part of the state and the deeper Dundee producing areas of the central and eastern parts (map in Fig. 1). In fact, the spring of 1939 saw several operating companies new to Michigan come in from the Mid-Continent and set up district offices in Grand Rapids, Holland, and Kalamazoo and by summer a number of well established Michigan independents moved from Saginaw and Mount Pleasant to establish new headquarters at Grand Rapids.

The reason for this shift, though primarily economical, had as its background the establishment of a definite Traverse producing area of regional magnitude throughout at least six counties of southwestern Michigan. That there were favorable structural conditions in this region had been recognized for a number of years, but it took the Salem, Bloomingdale, and finally Grand Rapids fields to prove that regionally the Traverse was a widespread porous producing formation in the southwest counties where the Bell shale and the Dundee strata had been eliminated by overlap. The reworking of these beds, which must have taken place where they thin toward the Kankakee arch, apparently caused localized barrier reef-like conditions near the top of this formation in these southwest counties instead of the bioherm-type reefs so characteristic of the outcrop in the northern part of the Southern Peninsula and manifest in the "spotty" Traverse porosity of wells in the "Basin."

In much of 1939, the Michigan production of crude petroleum was more than 2 million barrels monthly. Bloomingdale was the leading field in output until July when Temple went ahead. The Grand Rapids field took the lead in November, but with 539,090 barrels for December it had not reached its peak at the end of the year. From the monthly production figures in Table I it can be noted that at the end of 1939 the Grand Rapids and Temple fields were producing together in excess of a million barrels monthly. This was the first year since the Muskegon "boom" in 1929 that western Michigan fields had taken the lead over those in the "Basin."

BLOOMINGDALE FIELD

The Bloomingdale field with its various extensions is located in parts of Secs. 7, 8, 9, 11, 13, 14, 15, 16, 17, and 18, Bloomingdale Town-

TABLE I

MONTHLY PRODUCTION BY FIELDS IN MICHIGAN DURING 1939

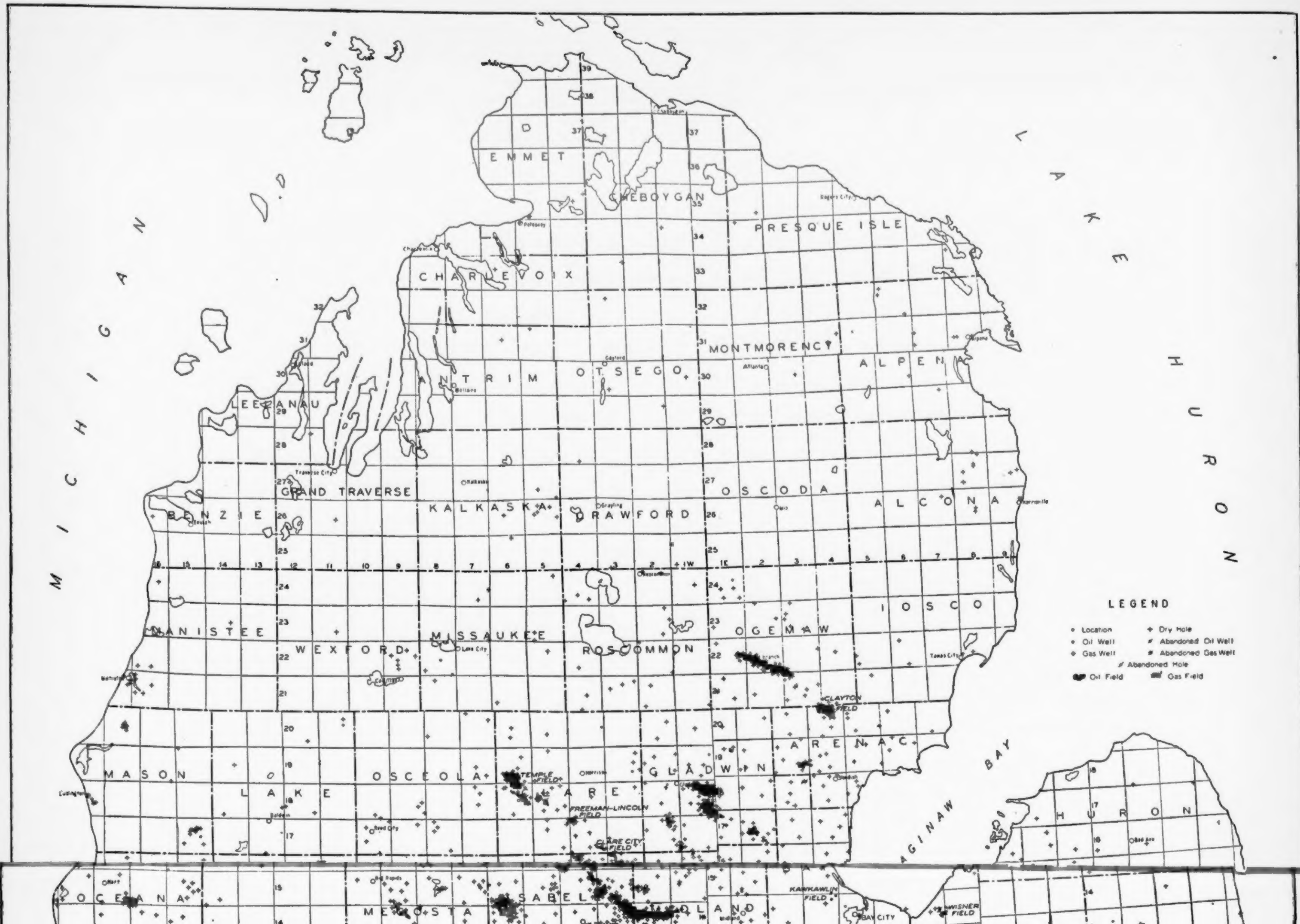
	Blooming-dale	*Mill Lake*	*Columbia*	*Walker*	*Wyoming Park*	*Redding*	*Freeman*	*Salem*	*New Salem*	*North Buckeye*	*South Buckeye*	*Porter*
January	474,765	10,612	2,262	1,673		259,809		35,913	7,313	258,009	51,028	123,688
February	410,936	13,136	1,767	9,495		308,758		36,210	19,932	212,832	50,055	111,408
March	407,549	20,361	8,743	20,776		401,186		32,098	35,168	232,633	42,602	124,426
April	356,888	39,705	42,874	69,892		430,785		44,470	87,875	214,286	38,616	115,135
May	340,379	65,469	178,525	186,730		438,034		53,599	124,607	200,410	37,364	117,389
June	301,167	23,817	153,035	201,853		399,328		69,561	152,600	180,895	33,214	112,362
July	239,865	17,822	174,086	285,157		446,739		92,953	162,529	171,754	32,469	110,959
August	226,245	10,488	184,977	300,586		432,854		89,141	179,387	157,671	28,936	110,971
September	190,948	7,850	131,349	311,388	873	397,825		86,351	129,856	126,352	25,449	102,473
October	165,282	5,562	114,371	414,245	4,211	354,568	97,731	83,601	141,717	127,196	24,659	103,904
November	134,852	4,094	120,166	484,209	3,633	385,943	71,469	67,019	148,157	108,050	20,901	99,090
December	121,828	4,115	100,226	535,081	4,009	412,871	62,844	58,975	126,791	109,746	16,961	99,187
Total	3,370,704	223,031	1,212,381	2,821,085	12,726	4,900,744		749,891	1,315,932	2,099,834	402,254	1,330,992

	Yost-Jasper	*Mount Pleasant*	*Sherman*	*Vernon*	*Wise*	*Eden-ville*	*Beaver-ton*	*South Beaverton*	*Bentley*	*West Branch*	*Clayton*	*Adams*	*Kaw-kawlin*	*Birch Run*
January	55,800	42,259	51,734	15,893	6,017	49,937	4,023	927	22,857	65,645	65,072	4,182	1,507	1,427
February	49,958	40,047	40,003	16,336	6,020	37,332	4,445	665	17,471	45,934	67,187	4,185	1,803	1,193
March	58,218	43,714	44,816	18,006	12,135	34,568	4,609	1,612	17,384	53,952	55,612	5,515	1,799	1,472
April	52,661	40,444	37,368	16,347	19,188	31,843	3,802	1,002	17,114	46,019	50,323	5,019	964	1,257
May	51,743	44,899	34,326	17,129	25,691	31,006	3,175	1,210	15,614	54,573	66,564	5,305	1,436	1,356
June	50,300	39,146	29,371	15,288	22,012	25,219	3,790	1,312	14,267	53,657	55,285	4,699	2,525	1,112
July	49,559	39,950	29,861	15,409	18,904	22,289	3,743	1,010	14,522	49,139	47,080	3,952	1,488	1,234
August	47,347	38,646	32,687	15,527	21,961	20,380	3,827	585	14,003	47,516	48,664	3,805	1,249	986
September	44,916	36,646	32,927	13,966	27,371	17,280	3,498	1,199	13,962	48,149	48,379	4,065	854	1,077
October	46,632	35,237	34,472	14,771	33,575	16,855	3,233	709	13,436	37,658	37,263	4,179	1,429	1,076
November	43,465	37,838	32,346	16,246	37,402	14,182	2,892	1,062	13,579	44,597	53,448	4,900	1,503	1,216
December	44,056	35,205	32,887	16,522	38,423	14,621	3,613	1,718	13,179	51,390	43,600	3,811	1,954	1,109
Total	594,655	474,031	432,798	191,440	268,699	315,512	44,650	13,011	187,388	598,229	638,477	53,617	18,511	14,515

TABLE I—*Continued*

	Leaton	*Crystal*	*Mus-kegon*	*Akron*	*Saginaw*	*Deer-field*	*Edmore*	*Currie*	*Clare (City)*	*Overisel*	*Bangor*	*Diamond Springs*	*Monterey*	*Hopkins*
January	14,159	11,509	3,750		880	445	1,899	1,226	391	43,022		24,083	3,339	
February	11,403	11,738	4,835		3,116	539	1,805	718	470	35,339		13,205	3,750	4,019
March	16,146	13,968	3,778	1,452	1,581		2,298	1,016	217	31,804	3,441	11,347	4,816	4,996
April	15,397	11,595	4,420	245	2,745		1,938	1,095	592	31,675	6,602	6,045	3,752	8,749
May	15,510	10,491	4,290	140	728	818	1,551	996	289	23,945	8,712	6,416	4,558	4,877
June	13,256	10,382	3,613	119	3,081		2,125	716	195	18,437	12,514	9,149	2,379	8,279
July	14,152	9,811	4,615	283	1,183	2,215	1,685	1,136	427	17,726	11,288	16,067	4,148	5,917
August	12,362	9,102	5,700	1,551	945	2,123	1,857	732	143	16,469	5,636	10,538	5,437	5,580
September	13,817	9,669	3,051	250	796	1,726	1,646	736	419	14,191	7,738	9,022	9,230	5,011
October	12,035	7,818	4,585	5,020	4,022	3,729	2,538	1,033	611	14,612	10,646	9,837	7,471	3,934
November	13,776	8,298	3,448	1,517	3,298	2,839	1,583	427	280	21,141	7,226	7,837	4,796	4,079
December	11,872	9,114	2,486	560	1,831	5,060	1,689	1,011	498	35,767	3,869	6,850	3,460	3,593
Total	163,885	123,495	48,571	11,137	24,206	19,494	22,614	10,842	4,532	304,128	77,672	130,396	57,136	59,034

	Dorr	*Zeeland*	*Trow-bridge*	*Porter Van Buren*	*Pine*	*Secord*	*Geneva*	*Tall-madge (Sec. 27)*	*Mount Haley*	*Win-field*	*Lake-field*	*Larkin*	*Fre-mont*	*Total*
January	12,956		49				564		211	145	69	72		1,731,121
February	11,585				1,608	155	516		215	144		193	68	1,612,529
March	10,551				989	864	517	116	218	144				1,789,213
April	7,593		118		1,082	409	452	227	151	121	205	144		1,869,229
May	6,486		304		646		370	268	168	215	103		137	2,188,551
June	6,930		342				428		257	142	139	165		2,038,534
July	5,436		501		1,126	469	499	269	84	141	69	47	70	2,131,837
August	5,165	138	1,010		1,810	236	387	393	171	189	139			2,106,252
September	4,488	2,270	569			214	315	424	170	142	149			1,891,046
October	3,688	1,944	470	69	436	358	319	283	168	71	71			2,013,340
November	4,323	1,250	207	101	883	217	425	311	148	143	140		80	2,041,032
December	3,396	693	378		1,379		441	304	141	217	80			2,049,411
Total	82,597	6,295	3,948	170	9,959	2,922	5,233	2,595	2,102	1,814	1,164	621	355	23,462,095


LAKE HURON
MICHIGAN
SAGINAW BAY
LEGEND
Location
Oil Well
Gas Well
Dry Hole
Abandoned Oil Well
Abandoned Gas Well
Abandoned Hole
Oil Field
Gas Field
EMMET
CHEBOYGAN
PRESQUE ISLE
CHARLEVOIX
MONTMORENCY
ALPENA
ANTRIM
OTSEGO
LEELANAU
GRAND TRAVERSE
KALKASKA
CRAWFORD
OSCODA
ALCONA
BENZIE
MANISTEE
WEXFORD
MISSAUKEE
ROSCOMMON
OGEMAW
IOSCO
MASON
LAKE
OSCEOLA
CLARE
GLADWIN
ARENAC
HURON
OCEANA
MECOSTA
ISABELLA
MIDLAND
BAY CITY
TEMPLE FIELD
FREEMAN-LINCOLN FIELD
CLARE CITY FIELD
CLAYTON FIELD
KAWKAWLIN FIELD
WISNER FIELD

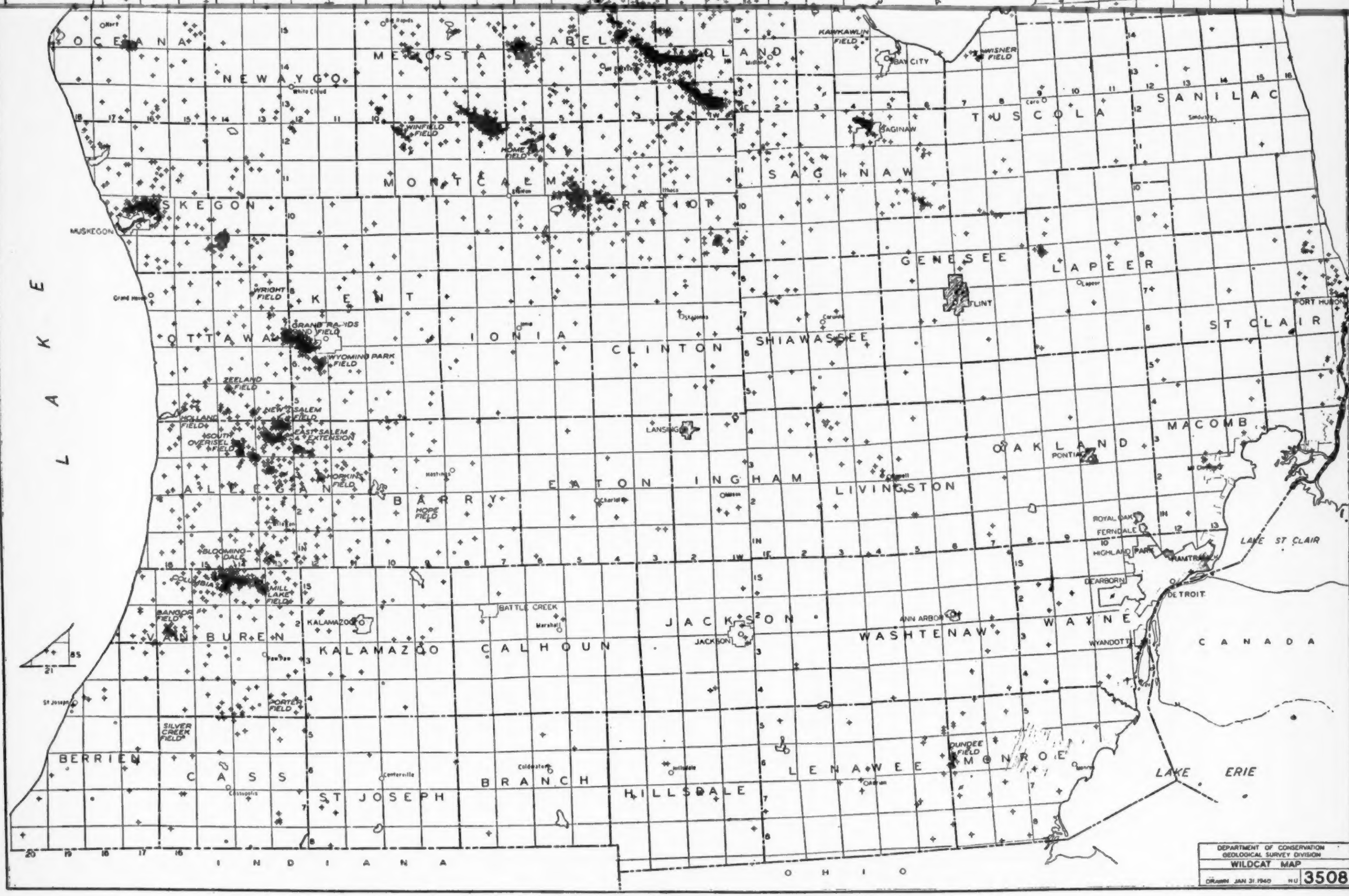


FIG. 1.—Active fields and discoveries in Michigan in 1939.

ship (T. 1 S., R. 14 W.) and Secs. 1, 2, 10, 11, 12, 13, 14, 23, and 24, Columbia Township (T. 1 S., R. 15 W.), Van Buren County, Michigan. It was discovered on August 22, 1938, by J. H. Fisher and S. L. McCall Trustees' M. Wiggins Estate No. 1 in the top of the Traverse formation at 1,221 feet depth. The producing zone in the Traverse is thin, being only 1–3 feet in thickness, but the structure extends east and west for 8½ miles and its greatest width in the east part of Columbia Township is 2½ miles. This field, the scene of the greatest drilling activity in the state during the latter part of 1938 and the first half of 1939, is the farthest southwest and the shallowest in depth of any size in southwestern Michigan.

Production is somewhat spotty and there are two non-productive saddles on the fold, one in eastern Bloomingdale Township and the other along the Bloomingdale-Columbia Township line. For this reason production statistics for the area are given in three divisions, Bloomingdale, Columbia, and Mill Lake. The Columbia part of the field really consists of two pools, Columbia proper and Bear Lake, or sometimes called East Columbia and South Columbia.

In its central part Bloomingdale was the locale of much town-lot drilling, which was not curtailed until a new conservation statute went into effect in the summer of 1939. Then it was too late, for the damage of close drilling had been done. The field was prorated for a short time beginning in June but by August the gas pressure was off so much that proration was lifted, just one year from the time of discovery.

TEMPLE FIELD

In Clare County of central Michigan the Temple field was discovered at about the same time as Bloomingdale. It was brought in by S. J. Higelmire Trustee's A. E. Van Horn No. 1 in Sec. 3, T. 18 N., R. 6 W., Freeman Township, at 3,894½ feet depth on July 9, 1938. The field has grown until it now embodies parts of Secs. 3 and 4, Freeman Township and Secs. 27, 28, 29, 32, 33, and 34, Redding Township. The major part of the producing area is in Redding, and the nearest village on the north is Temple from which the field gets its name.

This is a "Basin" field producing from a porous dolomitic zone close beneath the Bell shale and considered by most geologists of the Michigan region to be Monroe in age. It may be simply a dolomitic phase of the Dundee, but there is some evidence to the contrary. The producing characteristics of the field are similar to those in Sherman and Vernon, of Isabella County. Most of the wells in Redding Township are drilled on 20-acre spacing, with the well in the center of a rectangular 20-acre tract.

During much of its life at least part of this field was produced under proration. The restriction of output was first by pipelines and carriers, then voluntarily by producers to hold back the encroachment of water and to prolong the flowing life of their wells, and finally after June, 1939, by State supervision. It reached its peak of production in December, 1939, with 475,715 barrels for the month or an average of 15,345 barrels per day.

GRAND RAPIDS (WALKER) FIELD

Although the Grand Rapids (Walker) field was discovered prior to 1939, it was slow developing and at the start of the year there was only one drilling well in the area. The discovery of oil on September 24, 1938, by MacCallum and Herr's L. M. Story No. 1 in Sec. 32, T. 7 N., R 12 W., never caused much commotion and it was not until larger wells were brought in about $\frac{1}{2}$ mile east of this that the field really got a start. Then it took on major proportions quickly (Table I) and by June a real boom was in progress. At the end of 1939 the peak of the field's production had not yet been reached.

The Grand Rapids field produces from the Traverse at 1,750–1,900 feet depth, and the porous zones are farther in the formation than the Allegan or Van Buren County fields. The limestone section in which porosity is found is 30–50 feet thick, but the actual pay section is much less than this. It may total 3–12 feet. There are usually two important Traverse pay zones, one about 25 feet and the other about 40 feet in the "lime," and small quantities of bottom water occur at about 50 feet from the top.

Large quantities of shallow gas have been found in the Berea (?) producing horizon at 1,070–1,100 feet but no commercial use is made of this gas except for fuel in drilling. It has created a hazard in some sections of the field and in one well it broke away under the pipe so that gas migrated upward into the Marshall formation only a short distance under the glacial drift. This was the cause of great concern by the operators of several gypsum mines in the vicinity where gypsum is taken from the Michigan formation above the Marshall. One of these companies drilled its own property for oil so as to satisfy itself about the adequacy of engineering practices and casing programs and confine the oil tests over the location of pillars that were left in the mine.

The way to the discovery and development of the Walker-Wyoming-Tallmadge producing district was pointed when the Salem field in Allegan County showed a northeast trend in the direction of Grand Rapids. The area which ultimately became the field was approximately at the intersection of the two trends determined by extending

the main axes of the Salem and Muskegon fields. The Grand River took a broad southward meander around the area in which doming was thought to exist and shallow bedrock of the Michigan formation quarried and mined near Grandville suggested comparatively strong off-structure dip and reversal. The shallow bedrock was thought to be under a region of abnormal dip because this condition had been characteristic of several Michigan producing structures. The shallow-well data, which had been greatly expanded by the holes put down to the Marshall in Grand Rapids for water to be used in air conditioning was contoured on the Marshall to show the top of the structure. This map, prepared in June, 1938, by Paul B. Whitney of the Wolverine Natural Gas Corporation, was based on the data from 35 water wells and core holes and the subsurface topography of three gypsum mines. The discovery well in the field was located on the north side of the area included by the highest closing Marshall contour, which later proved to be in proximity to the southwest edge of the field as now known.

The Grand Rapids field has not been prospected beneath the Traverse on the top of the structure. As the producing structure now stands, it embodies parts of Secs. 28, 29, 30, 31, 32, 33, and 34, Walker Township (T. 7 N., R 12 W.), Secs. 3, 4, 5, and 6, Wyoming Township (T. 6 N., R 12 W.) (the part of Wyoming north of Grand River being politically in Walker Township), and Secs. 14, 23, 24, 25, 26, and 36, Tallmadge Township of Ottawa County (T. 7 N., R. 13 W.). In addition there are two structures subsidiary to the main closure with producing wells, one of these productive areas being in Sec. 27, Tallmadge-Ottawa, and the other in Secs. 13, 14, and 23, Wyoming-Kent. The latter structure is known as the Wyoming Park field and is so called in the tabulation of production statistics. The Grand Rapids producing area might be named the "field of the year 1939" in Michigan.

OTHER ACTIVE FIELDS

Salem.—The Salem producing district in Allegan County was expanded in December, 1938, by the discovery of the New Salem pool northeast of the older field around Burnips. This pool, brought in by the Victory and Gordon Oil Companies' wildcat, reached a peak of 179,387 barrels for the month of August, and was still around 125,000 barrels monthly at the end of 1939. It was probably as well handled as any Traverse field in southwestern Michigan, with both voluntary and State supervised restriction holding back flowing wells under chokes, thus prolonging the period for which they would flow.

The original Salem pool was extended to the east in April by a discovery made by the Michigan Devonian Petroleum Company and its production jumped from between 30,000 and 40,000 barrels monthly at the start of the year to 92,953 barrels for the month of July.

Wise.—The Wise field, situated in Isabella County west of the old Vernon pool, was found in August, 1938, by the Turner Petroleum Company's J. B. White No. 1 (SE. $\frac{1}{4}$, NE. $\frac{1}{4}$, NW. $\frac{1}{4}$, Sec. 28, T. 16 N., R. 3 W.). The structural closure where this discovery was made now has 12 producing Dundee wells in Secs. 20, 21, 28, and 29. In January the field was extended northwest by the McClanahan Oil Company's Leo Nixon No. 1 (SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 17, T. 16 N., R 3 W.), and this new closure has become an area of extensive drilling with production being found in Secs. 8, 16, 17, 20, and 21. At the end of 1939 the Wise field, with wells at more than 3,650 feet depth, was making 38,423 barrels monthly but had not yet reached its peak. The Michigan "stray sand" carried commercial gas in a number of the wells in this field.

Dundee (Deerfield).—A surprising development in Michigan in 1939 was the revival of activity in the old Deerfield area in Dundee Township, Monroe County. Here, where nearly 20 years ago oil was first found in the Trenton formation (Ordovician) of Michigan from 2,050 to 2,200 feet, a new spurt of activity took place in Secs. 19 and 30, T. 6 S., R 6 E., resulting in the drilling of several producing wells. In July, 1939, the finding of bigger wells in this district made production jump from a few hundred barrels a month to 2,215 barrels, and in December the A. V. Oil and Gas Company's Gaertner No. 3 (NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 19, T. 6 S., R 6 E.) produced 800 barrels in 24 hours, causing the output for that month to increase to 5,060 barrels.

This new production is not large from the standpoint of its contribution to the total output of the state, but it does represent oil from a formation that has thus far been unimportant in Michigan. Much prospecting for Trenton oil in the southeastern counties should result from the commercial wells now being found in the Dundee field and the northwest-plunging noses off the Cincinnati anticline should be thoroughly tested in the years to come.

Wisner.—The Wisner or Akron field in Tuscola County is on an anticline east of Bay City and south of Saginaw Bay which is the southeast prolongation of the Buckeye trend. The Kawkawlin structure north of Bay City is on this same "high." Both of these structures are well outlined by test-well drilling to shallow markers, and several Dundee wells have been drilled within their closures without espe-

cially fruitful results, The Dundee seems to lack porosity in this part of the state.

This field was revived by a well deepened beneath the Dundee which produced commercially in the Monroe. By December, 1939, five producing wells had been completed in this porous Monroe which is 860–875 feet from the top of the Dundee. However, the area did not add greatly to the output of the state and did not create major attention because the wells were small and the crude oil was of inferior quality in some of its properties.

GAS FIELDS

The drilling for natural gas in 1939 was active in four fields: Freeman-Lincoln (Clare County), Home (Montcalm County), Winfield (Montcalm County), and Clayton (Arenac County). The first three of these fields developed gas in the Michigan "stray sand," the last in the Berea, both of these producing horizons being Mississippian in age. All of the developed gas fields of Michigan are at shallow depths with most of the wells less than 1,500 feet deep.

In the Clare County area gas production was brought in southeast of the Temple field and 11 wells were completed in Freeman Township (T. 18 N., R. 6 W.) and 6 wells in Lincoln Township (T. 18 N., R. 5 W.). In addition one gas well was completed in the field east of the city of Clare where the only commercial oil production from the Michigan "stray sand" is now being produced. The new wells near the Temple field are located in Secs. 9, 10, 13, 14, 15, 23, and 24, Freeman Township, and Secs. 7, 16, 17, 18, 20, and 21, Lincoln Township, and during 1939 they were tied into a pipeline constructed by the American Michigan Pipeline Company to connect with their line from the Austin field (Mecosta County) to Muskegon.

In the past year five additional "stray" gas wells were completed in Secs. 7, 8, 16, and 17 of the Winfield gas field (Montcalm County, T. 12 N., R. 9 W.), which had been previously connected by pipeline with the American Michigan Pipeline Company's Austin-Muskegon main trunkline. During the month of October a $3\frac{1}{2}$-inch gas line was laid southeast from this field to service Greenville, the largest city in Montcalm County.

The Home Township gas area (Montcalm County, T. 12 N., R. 6 W.), discovered by the Socony-Vacuum's Chris Hansen No. 1 (center of the N. $\frac{1}{2}$, NE. $\frac{1}{4}$, NE. $\frac{1}{4}$, Sec. 22, T. 12 N., R. 6 W.) in the spring of 1938, was the scene of considerable drilling for gas in 1939. The field was expanded to include parts of Secs. 14, 15, 21, 22, and 23, and during the year 9 new gas wells were completed. This district is situated

just southeast of the Six Lakes gas field and has considerable possibilities for additional extension westward in 1940.

In the Clayton field (Arenac County, T. 20 N., R 4 E.), where large gas flows were encountered in the Berea sand at 1,080–1,150 feet when the area was drilled up for Dundee oil, there were 17 Berea gas wells completed in 1939. These were located in Secs. 14, 15, 21, 22, 23, 26, and 27, and though an effort was made to drill them in the center of 160-acre drilling units many were put in the center of 40-acre tracts. Enough gas was developed in this field so that a 6-inch welded pipeline was constructed to Midland, where it joined with the main trunk-line of the Consumers Power Company from Six Lakes and Broomfield to Saginaw and Bay City.

New gas discoveries were made in Ottawa County during the fall from the sandy dolomite in the Ellsworth formation (Berea?) which produces commercially in the Ravenna field and carries good gas flows in the Grand Rapids field. The Daily Crude Oil Company's George Herman No. 1 (NW. ¼, NW. ¼, NE. ¼, Sec. 11, T. 8 N., R. 14 W.) in Polkton Township, drilled during October, had 248,000 cubic feet at 1,206 feet depth. The same company's Frank Hambelton No. 1 (NW. ¼, NW. ¼, NW. ¼, Sec. 19, T. 8 N., R. 13 W.) in Wright Township was completed as a gas well with "pay" at 1,193–1,198 feet, good for 3,340,000 cubic feet of initial open flow. The Crown Development Company's Stanley J. Williams No. 1 (SE. ¼, SE. ¼, SE. ¼, Sec. 7, T. 8 N., R. 13 W.) also made gas from the same "pay."

The State supervision and proration of gas fields in Michigan is in charge of the Michigan Public Service Commission and administered by its engineering department. They have ruled that 160 acres is the standard drilling unit for the shallow producing districts, and proration is made on this basis from periodic pressure and open-flow tests made by the "critical-flow" method outlined by E. L. Rawlins and M. A. Schellhardt of the United States Bureau of Mines.

DISCOVERIES IN 1939

During 1939 several discoveries were made but none of them resulted in a major field and they were seemingly of minor importance in making large new reserves available. These were Hopkins (Allegan County), Bangor (Van Buren County), Zeeland (Ottawa County), Porter (Van Buren County), Silver Creek (Cass County), South Overisel (Allegan County), and Hope (Barry County). The localization of most of these discoveries in southwestern Michigan was due to the concentration of wildcatting in this district from the boom caused by fields in Kent, Ottawa, Allegan, and Van Buren counties

and the cheapness of shallow prospecting for the Traverse as compared with deeper drilling for the Dundee in the "Basin."

The Hopkins field was discovered by Bell-Marks, Incorporated's Brower No. 1 (NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, NW. $\frac{1}{4}$, Sec. 23, T. 3 N., R. 12 W.) on January 24, 1939, which was good for 90 barrels, natural flow, and 400 barrels after acid treatment, from the Traverse at 1,635 feet. At the end of the year there were seven producing wells in the field and it had then been limited by dry holes to a small area in Secs. 22 and 23. The peak production was reached in the month of April.

The Bangor pool in Van Buren County was discovered, February 14, 1939, and the peak monthly production of 12,514 barrels was in June. The discovery well in this district was Blood and Hendershott's Joe Jackson No. 1 (NE. $\frac{1}{4}$, NE. $\frac{1}{4}$, NE. $\frac{1}{4}$, Sec. 29, T. 2 S., R. 16 W.), which made 75 barrels of oil and 10 per cent water on the pump after treating with acid. The wells in the field produce from the Traverse at about 1,000 feet depth and at the end of 1939 there were 10 producers in Secs. 20, 21, 28, and 29, Bangor Township.

The discovery in Zeeland Township, Ottawa County, was made by the Freeman Oil Company's Gerritt Huyser No. 1 (SW. $\frac{1}{4}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 5, T. 5 N., R. 14 W.) on September 4, 1939. This well made 160 barrels of 31° Bé. gravity crude oil in 12 hours after acid treating, from the Traverse at 1,660 feet. It proved a distinct disappointment, however, when both north and south offsets and wells a short distance east and the northwest diagonal offset were dry.

Small production was discovered on October 4, 1939, by the R. T. and E. Corporation's J. J. Theisen No. 1 in Porter Township, Van Buren County (SW. $\frac{1}{4}$, SE. $\frac{1}{4}$, SW. $\frac{1}{4}$, Sec. 18, T. 4 S., R. 13 W.). This Traverse well at 1,345 feet made 13 barrels in 12 hours after acid, but it was never more than a small pumper. A second well on the same farm showed some oil but it was finally plugged and abandoned.

On October 10 a small quantity of 29° Bé. gravity oil was found in the Silver Creek Oil Company's Lee Flynn No. 1 (NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, NW. $\frac{1}{4}$, Sec. 23, T. 5 S., R. 16 W.) in the Traverse at 823 feet and the well made 7 barrels of oil per day, natural flow. Attempts were made for several weeks to pump the well and for some time it was considered commercial, but finally it was plugged and abandoned.

The development leading to the discovery of the South Overisel pool in Allegan County was started by E. P. Wyman Trustees' Albert Vander Poppen No. 1 (NW. $\frac{1}{4}$, NW. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 27, T. 4 N., R. 14 W.). This well led to drilling in the south end of the original Overisel pool which extended production southward across a struc-

tural saddle to a new closure in Section 34. The discovery well here was Chas. W. Cook's A. Kopper No. 1 (NW. $\frac{1}{4}$, NW. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 27, T. 4 N., R. 14 W.) which came in, September 30, 1939, flowing 150 barrels. At the end of 1939 five producing wells had been completed in the "saddle" and three on the new closure of South Overisel. The entire Overisel field jumped from a low of 14,141 barrels in September to 35,767 barrels for the final month of the year and much new drilling was projected for 1940.

The Hope field in Barry County was opened by N. A. Trexler's Bagley No. 1 (NE. $\frac{1}{4}$, NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, Sec. 27, T. 2 N., R. 9 W.) on December 21, 1939. This well, with top of the Traverse at 1,867 feet, was not a large producer, but it was on a structural feature of some size and looked like the beginning of a new producing area. It was the first commercial oil well in Barry County.

PRORATION AND PRICE

A new conservation statute providing for proration and well spacing became a law in Michigan in the summer of 1939. This oil-control bill placed supervision of oil wells after proper hearing except in emergencies under the director of the Department of Conservation as "supervisor of wells" and created an advisory board of six men from the petroleum industry (three majors and three independents) with staggered term, to consult with the supervisor. The Conservation Commission constituted an appeal board to the rules and regulations of the supervisor if contested.

The first order of the supervisor of wells was in June and required a 200-barrel daily prorate on flush fields with 10-acre spacing as a base, except in the Temple field where the wells were prorated to 125 barrels if drilled on 10-acre spacing and 250 barrels if drilled on 20-acre spacing. Early in August proration was lifted from the Bloomingdale field and on August 23 it was cut from 200 to 100 barrels for wells with 10-acre spacing in the Walker, Columbia, and New Salem fields. Later in the fall proration was also lifted in Columbia, Van Buren County. In all of these orders the allowables for wells on tracts smaller than the minimum spacing unit were in the proportion of the acreage involved to that of the unit set for the field.

On November 6 a ruling was issued allowing 5-acre spacing in the Dundee field (Monroe County).

At the beginning of 1939 crude oil prices in Michigan were greatly depressed below those posted for comparable grades in other parts of the country, taking into consideration the transportation differentials involved. In late April the price of Allegan and Kent County

crudes was advanced from 78¢ to 88¢ a barrel. In October the posted price for flush oil of southwestern Michigan was advanced again to 95¢ and another increase in November placed it at $1.03 per barrel, where it stood for the remainder of the year.

During 1939 a number of new crude-oil purchasers entered the field in the southwest part of the state and these may have contributed to the strengthening of price. At year's end the principal purchasers included the Sohio Corporation, the Imperial Refining Company, the Naphsol Refining Company, the Commonwealth Pipeline Company, the Vandale Pipeline Company, the Leonard Pipeline Company, and the Marvel Refining Company.

GEOPHYSICAL PROSPECTING

The use of geophysics in Michigan has not grown in general favor and although some very good work has been done it has never paid very big dividends. In 1939 several seismograph crews were active, but along with other disturbing factors shooting through the thick glacial drift was still a problem difficult to cope with and even though some of this shooting work checked out in a general way with drilling that followed, no discoveries resulted from it. Soil-analysis work was reported but the results were not disclosed, and the magnetometer also was run over a few prospects. Several major companies used gravimeters rather extensively but no discoveries were credited to findings from them. The faculty of the physics department of Michigan State College continued with the supervision of student resistivity studies on the Howell structure (Livingston County).

During the fall International Geophysics, Inc., of Los Angeles, commenced echometer bottom-hole pressure tests in coöperation with the State Geological Survey. They also made tests on fluid levels in Walker, New Salem, Temple, and Wise fields. These studies were to be continued at more or less regular monthly intervals to assist in proration and other forms of State regulation.

The most satisfactory methods of prospecting in Michigan are still test-well drilling for structure, and wildcatting based on subsurface studies of trends and closures aided by interpretations from isopach maps of formations or intervals and careful cross sectioning.

DEEP TESTS

During late years a number of wells have found showings of oil and gas in the lower beds of the Detroit River (upper Monroe) or in the upper cherty strata of the Sylvania, and small Monroe production having been developed in the Wisner field, several on-structure wells in other fields were deepened to the Sylvania in 1939.

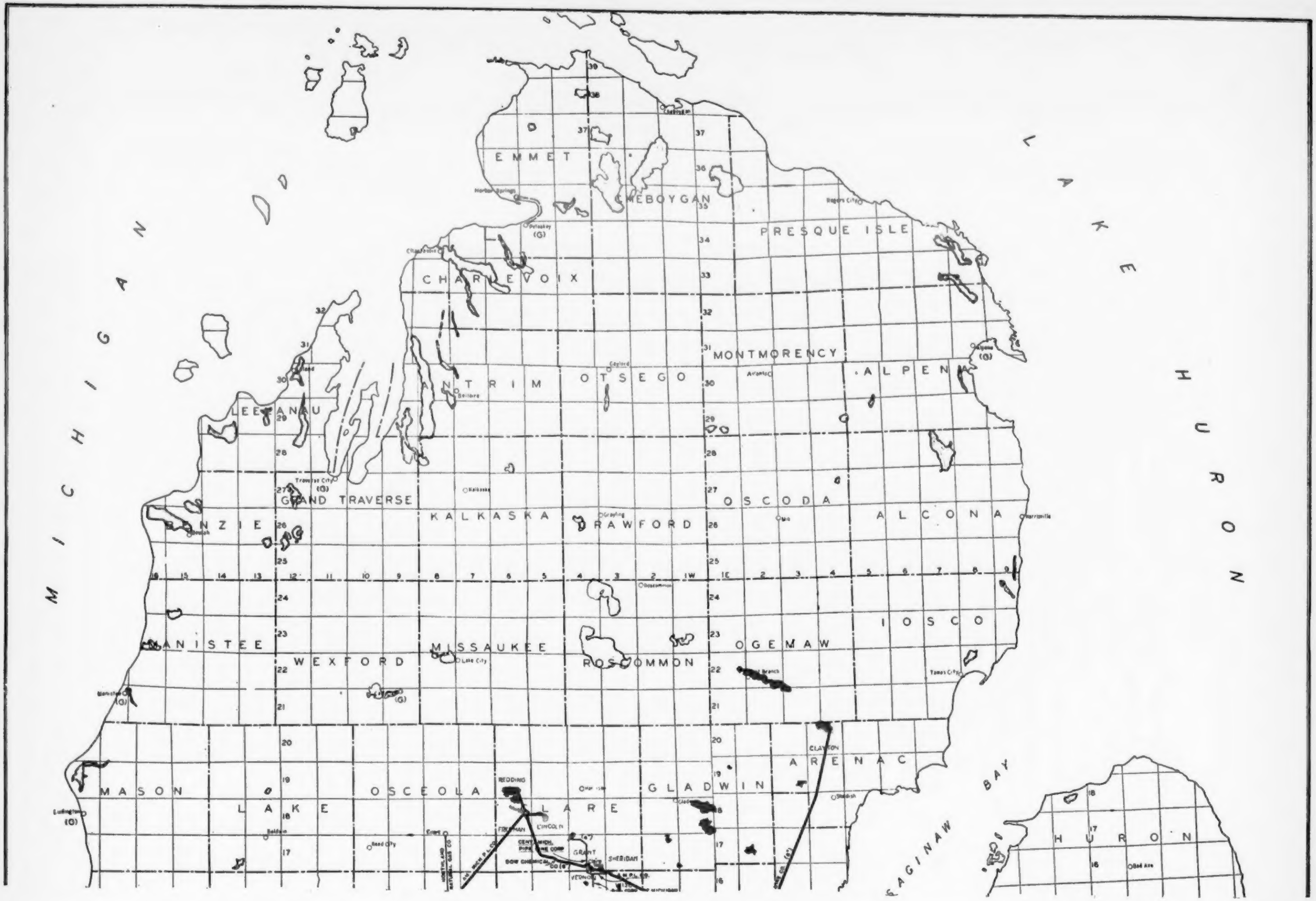
In the Porter field (Midland County), Carter Lease, Incorporated's Maywood Carter No. 6 (NW. $\frac{1}{4}$, SW. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 18, T. 13 N., R. 1 W.) started deepening below the Dundee but this well was not completed at the end of the year. A number of wells in the Buckeye field (Gladwin County) were deepened 16–20 feet and found additional Dundee "pay," and the J. V. Wicklund Development Company's State "A-1" in north Buckeye (discovery well) was put down from its original total depth of 3,616 feet to 4,696 feet, where it was completed in December. It encountered a "rainbow" at 4,510 feet and a small showing of oil at 4,570 feet, but water came in at 4,696 feet. H. C. Nelson deepened his W. M. Williams No. 1 (SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 9, T. 1 S., R. 14 W.) in the Bloomingdale field (Van Buren County) from 1,264 to 1,681 feet, but no new oil "pay" was found and a "hole full of water" came in at 1,573 feet.

The Gulf Refining Company's Bateson No. 1 (center of the S. $\frac{1}{2}$, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, Sec. 2, T. 14 N., R. 4 E.), Monitor Township, Bay County, on the Kawkawlin structure was a deep test that was watched with considerable interest in 1939 because of the test-well drilling and seismograph work that led to it location and the similarity between this structure and Wisner where Monroe oil was already being produced. Besides the oil from several Dundee pay zones this well filled with 200 feet of oil in the Monroe at 3,515–3,520 feet, and 1,100 feet of oil and 300 feet of water in the Sylvania at 3,955–3,970 feet. The top of the Sylvania was penetrated at 3,945 feet and water came in the hole at 4,174–4,177 feet, 4,303–4,309 feet, 4,340–4,350 feet, and 4,360–4,370 feet, which was the total depth of the hole. It was plugged back to 3,817 feet where it made 71 barrels the first 12 hours and 64 barrels the second 24 hours.

PIPELINES AND REFINERIES

In 1939 there was no major oil pipeline construction in Michigan, but a number of gathering-line connections to truck loading spots and railheads were made. The Bay Pipeline Company projected a new feeder line from the Wise pool (Isabella County) to their Buckeye-Bay City trunkline system, and the Simrall Pipeline Company also made a spur for connections in Wise. New boosters were installed on the Michigan-Toledo Pipeline at Dundee, Michigan, and a feeder was constructed from this line to the Dundee field. The Sohio Corporation shipped tank cars of crude oil from Van Buren County and other southwestern Michigan fields to this line at Chelsea by rail, and piped it into Toledo.

Pipeline construction for transporting natural gas was much more



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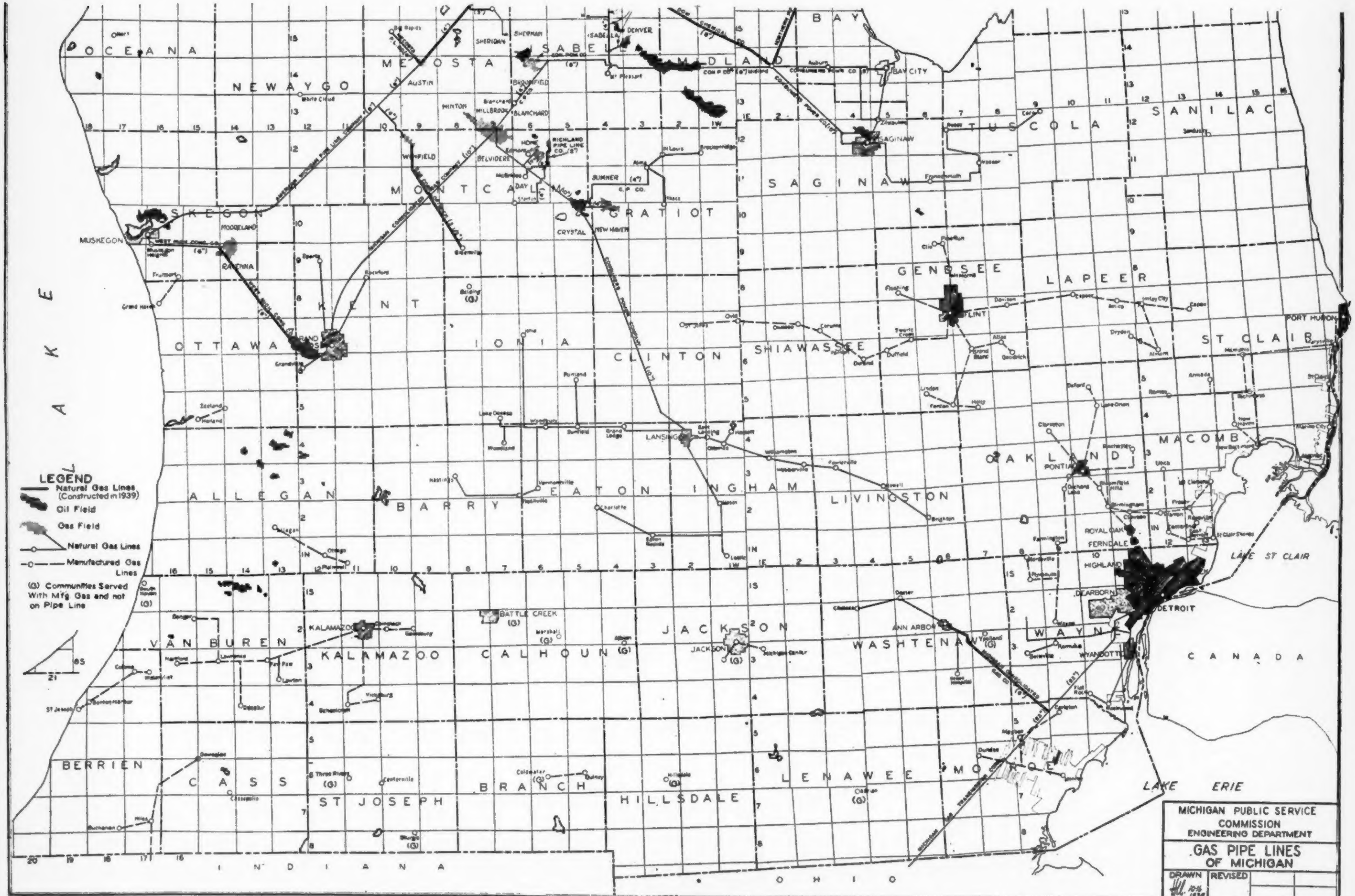

FIG. 2.—Natural-gas pipelines constructed in 1939.

active than for oil (map in Fig. 2). The West Michigan Consumers, Inc., built an 8-inch welded pipeline 21 miles long from the end of its line in the Ravenna gas field (Muskegon County) to the Pent-Hex casinghead gas absorption plant in the Grand Rapids field. This plant was constructed with capacity to process 10–15 million cubic feet of wet gas daily, for which a price of 5.3¢ per thousand was to be paid.

The American-Michigan pipeline from the Freeman-Lincoln gas field (Clare County) to the end of its Muskegon line at the Austin field (Mecosta County) was 4-inch welded construction. Other gas lines previously mentioned under the discussion of gas fields were the 3½-inch welded line from Winfield to Greenville and the 6-inch line from Clayton to Midland.

The Michigan Consolidated Gas Company built a 6-inch main from the Michigan Gas Transmission Corporation's line into Detroit to service the city of Ann Arbor. The Dow Chemical Company commenced construction of a 6-inch line from the Grimes casinghead gasoline plant in the Redding pool (Temple field, Clare County) to its main chemical works in Midland, and completion of the line was expected early in 1940.

Five small refineries were constructed in the proximity of southwestern Michigan fields: two at Bloomingdale, two at Grand Rapids, and one at Kalamazoo. The Fort-Dale Oil and Refining Company refinery at Bloomingdale was a 1,500-barrel skimming plant, and the Glenco Refining Company's refinery was of similar construction and 1,800 barrels capacity. The Imperial Refining Company's Refinery No. 2, of 4,000 barrels skimming capacity on Chicago Drive between Grand Rapids and Grandville, was completed on November 1, and the Marvel Refining Company's 1,800-barrel plant was built in the same vicinity. The new refinery at Kalamazoo was a 1,400–1,500-barrel skimming plant owned by the Peerless Oil Purchasing Company. Several other established refineries in the state added new equipment, and at the Pentagon Refining Company's skimming plant at Starks near Plymouth a new still was built.

The older refineries with cracking and reforming units at Mount Pleasant, Alma, St. Louis, and Muskegon so increased their output of marketable high-octane gasoline during the year that retail gasoline prices dropped sharply, especially in Grand Rapids and western Michigan. For several months in the fall and winter of 1939 the filling-station retail price in Grand Rapids stood at 12½ cents, and 8 gallons for $1.00 was the standard price, even at major company outlets.

SUMMARY

The production of crude oil in Michigan during 1939 was sufficiently buoyed from the output of three flush fields so that the total volume of oil for the year exceeded any in the past. The southwestern counties saw most of the wildcatting and the development work of the petroleum industry in the state was divided into two camps: exploration for Dundee oil in the "Basin" and for Traverse oil in southwestern Michigan. Discoveries of the year did not keep pace with decline despite the quickening of wildcatting activity by the improvement of crude-oil prices, and unless deeper production or new flush fields are found the outlook for 1940 in this area is not particularly bright.

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DEVELOPMENTS IN NORTH MID-CONTINENT IN 1939[1]

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ABSTRACT

Drilling activity in Kansas dropped about 14 per cent below the previous year and 48 per cent below 1937. The dry-hole percentage dropped from 27.2 per cent to 24.7 per cent. Initial oil production per well rose from an average of 1,208 barrels to 1,577 barrels, due in part to the increasing use of draw-down methods of taking potentials. More than 1.5 million barrels of new potential were added to the state and new highs in potential capacity were reached nearly every month. Wildcatting was practically at a standstill, except in northeast Kansas, where a dozen stratigraphically deep tests were drilled in the Forest City basin and north flank of the Chautauqua arch. Norton and Phillips are new oil-producing counties, but the discovery well in each is small and of questionable commercial value. A gas discovery in Sherman County producing from the Cretaceous is important only because it is in a previously unproductive county. Many fields on the Central Kansas uplift were joined during the year, so that, although there were twenty-one oil and gas discoveries officially adopted during the year, there are fewer separate fields now than at the beginning of 1939.

Missouri received the major share of the drilling phase of the Forest City basin play, which was one of the most active in the United States in 1939. Twenty-three deep wildcats and many shallow Pennsylvanian tests were drilled in the state during the year without success except for a few marginal gas wells in old areas. Most of the wildcats tested all possible producing formations to the Arbuckle group. Not all activity was confined to the Forest City basin as several wells were drilled in central and northeastern Missouri. Inasmuch as more than half the wells drilled were located on some type of surface structure, the failure of even one test to find a showing of free oil in pre-Pennsylvanian rocks confirms the opinion of those geologists who refused to be stampeded by the hysteria of the Forest City play.

Six dry holes were completed in Nebraska in 1939, none of which is in the Forest City basin. The Pawnee Royalty Company's Boice No. 1, in Sec. 18, T. 1 N., R. 16 E., Richardson County, will probably be considered the discovery oil well of Nebraska, although at present it has not been successfully completed as a commercial producer. It found oil, November 1, at 2,276–2,281 feet in the upper part of the Devonian, which indicated commercial production. At present it is being deepened, and the nearest test to it appears to be a dry hole in the Arbuckle group.

In South Dakota, wells in Union and Charles Mix counties were completed in pre-Cambrian rocks, adding much valuable stratigraphic information. There was a little drilling activity in the Iowa part of the Forest City basin, but no completions.

A study of the stratigraphic data revealed by the drill in the area of this review during the past few years shows that many old published ideas must be abandoned completely and others must be radically revised. The geologic history of the area can be much better understood and new stratigraphic and structural problems are being cleared up.

INTRODUCTION

A wildcat play in the Forest City basin of northeast Kansas, northwest Missouri, southeast Nebraska, and southwest Iowa assumed such proportions as to overshadow the rather routine development of Kansas oil fields. Encouraged by the discovery of prolific production in the Illinois basin, independent and major oil companies investigated the oil possibilities of the Forest City basin in a play reminiscent

[1] Read before the Association at Chicago, April 12, 1940. Manuscript received, April 29, 1940.

[2] Geologist, Darby Petroleum Corporation.

of the early days of the oil industry. Wells were located by means of many types of geology and geophysics, but most of them were located more or less at random. Except for a Nebraska oil discovery, the value of which remains doubtful at present, attempts to find commercial oil production in the Forest City basin in 1939 met with failure.

KANSAS

DRILLING ACTIVITY

The drilling activity in Kansas for the last 2 years is summarized in Table I.

TABLE I

SUMMARY OF 1939 DRILLING IN KANSAS

	1939	*Per Cent*	*1938*	*Per Cent*
Oil wells	983	70.8	1,122	69.0
Gas wells	62	4.5	62	3.8
Dry holes	343	24.7	442	27.2
Total	1,388		1,626	

This decrease of 14 per cent is illustrative of the decline both in wildcat activity and development for the state as a whole.

Although fewer oil wells were completed in Kansas in 1939, the potential production of these wells was 1,548,772 barrels, compared with 1,355,507 barrels in 1938, or an average of 1,577 barrels compared with an average of 1,208 barrels. The average gas well of 20,661,000 cubic feet, compared with 12,561,000 cubic feet in 1938, supplied a capacity of 1,280,974,000 cubic feet compared with 778,763,000 cubic feet.

An innovation during the year was the drilling of three stratigraphic tests, that is, deep tests drilled for geologic purposes only. Other such tests, about which no information is released by the operating company, are planned for 1940.

POTENTIAL PRODUCTION

Inside-drilling activity, discovery of new pools, and important extensions have again raised Kansas potential production. At the close of 1938 the official state potential was 3,681,016 barrels per day. This figure had increased to 4,711,054 barrels from 19,649 wells on December 20, 1939, and had further increased to a peak of 5,218,583 barrels from 19,835 wells on March 20, 1940.

LEASING ACTIVITY

The major leasing activity in Kansas occurred in the northeast

part of the state. Several dozen blocks were taken, but most of the acreage was of the checkerboard variety. Inasmuch as most of the early acreage taken carried low rental payments, much of this will be carried for several years.

In the first nine months of the year more acreage was dropped in western Kansas than was leased. Several companies reduced their holdings considerably, and thinned out their checkerboard play. During the last quarter the trend was reversed by a few of the major companies, although many leases in non-producing counties were being dropped. Renewals of expiring leases constituted a large part of the leasing activity throughout the year.

PRORATION REGULATIONS

Senate Bill 185 providing a new set of laws concerning the conservation of oil and gas was passed in March. Subsequently, after much deliberation the Corporation Commission issued a new set of rules and regulations for proration. The introduction of the acreage factor in proration was probably the most important feature of the new regulations. The ten-acre location is considered the basic pattern of drilling in the state, and wells drilled on a spacing larger than ten acres are allowed a proportionately larger amount of production. Twenty-acre spacing was thus encouraged, and is the normal pattern in several of the new fields.

The acreage factor has been applied likewise to the development of the gas reserves of Kansas, notably the Hugoton, Lyons and Cunningham fields.

WILDCATTING

Table II classifies all wildcat wells in western and northeastern Kansas in 1939 according to the method of location.

TABLE II

	Success Percentage	*Producing*	*Dry*	*Total*
Non-geological				
Chance		0	29	29
Expiring leases or unknown		9	13	22
Geological				
Surface		4	6	10
Subsurface		5	9	14
Core drill		2	9	11
Seismograph		1	4	5
Core drill and surface		0	2	2
Core drill and seismograph		0	1	1
Seismograph and subsurface		0	1	1
Magnetometer		0	1	1
Non-geological	17.6	9	42	51
Geological	27.2	12	32	44
		21	74	95

It seems from Table II that the chances of discovering new production were almost as favorable without geology as with it. However, of the nine non-geological discoveries of the table, three eventually will prove to be extensions of known fields, five are one-well pools not of commercial value, and one is a one-well pool whose importance is doubtful. No appreciable reserve can be attributed to these non-geological discoveries.

Table III shows a comparison of wildcatting in 1938 and 1939.

TABLE III

	Oil and Gas Wells	*Footage*	*Dry Holes*	*Footage*	*Total Wells*	*Footage*
1938	43	148,050	129	478,389	172	626,439
1939	21	67,259	74	258,031	95	325,290
Decrease	22	80,791	55	220,358	77	301,149

Twenty-two of the 1939 wildcats were drilled on farmed-out leases. Five of them discovered new pools.

The average depth of discovery wells is 3,202 feet, compared with 3,443 feet in 1938. The average depth of dry holes is 3,487 feet compared with 3,708 feet in 1938. The lesser depth of dry holes in 1939 is due in part to the drilling of wells in the Forest City basin, but also to the scarcity of deep tests in southwestern and far western Kansas. The deepest test in the state in 1939 was drilled to 6,503 feet and only a dozen dry wildcats exceeded 4,000 feet in depth.

PIPELINE ACTIVITY

Kansas has suffered due to lack of adequate pipeline capacity as well as loss of its crude oil markets to other states. Some relief from this situation was expected by the construction early in 1940 by Standard Oil Company of Indiana of a line from the Bemis pool in Ellis county to its station at Washington, Kansas, on its line from Wyoming to the vicinity of Kansas City. This line will consist of 127 miles of 10-inch and 7 miles of 8-inch, and will have an initial capacity of about 11,000 barrels per day, with possibilities of expansion. No other important pipeline construction was announced or completed in 1939.

NEW POOLS

Table IV lists the new pools discovered in Kansas in 1939 as named by the nomenclature committee of the Kansas Geological Society and the Mid-Continent Oil and Gas Association. Among the rank wildcats, a few are worthy of special mention. The Van Patton

TABLE IV

LIST OF CORRECTLY ADOPTED NEW AREAS OF PRODUCTION DISCOVERED IN WESTERN KANSAS WEST OF RANGE 3 EAST DURING 1939

Field	County	Section-Township-Range	Depth in Feet	Discovery Date	Producing Formation	Method of Exploration
1. Atherton North	Russell	18-13S.-14W.	3,134	6- 7-39	Arbuckle	Surface
2. Bornholdt North	McPherson	18-20S.- 5W.	3,343	12-31-39	Mississippian "lime"	Subsurface
3. Bow Creek	Phillips	25- 5S.-18W.	3,160	5-15-39	Oswald	Core drill
4. Bredfeldt West	Rice	12-18S.-10W.	3,268	12- 4-39	Arbuckle	X. A.
5. Cairo	Pratt	7-28S.-11W.	4,283	12-14-39	Viola	Core drill
6. Fairfield North	Russell	SW.¼ 15, SE.¼ 16, NE.¼ 21, NW.¼ 22-15S.-13W.	3,339	1- 1-39	Oswald Arbuckle	X. A.
7. Feltes	Barton	14-16S.-12W.	3,348	11- 4-39	Arbuckle sand	Subsurface
8. Harzman	Barton	33-16S.-11W.	3,132	10-29-39	Oswald	X. A.
9. Krier	Barton	29 & 30-16S.-11W.	3,325	10-31-39	Arbuckle sand	X. A.
10. Kruckenberg	Barton	14-19S.-15W.	3,632	1-15-39	Arbuckle	Seismograph
11. Midway	Rice	W.½ 4, S.½ NE.¼ & SE.¼ 5, NE.¼ 8, NW.¼ 9-20S.- 9W.	3,259	4-10-39	Arbuckle	Subsurface
12. Pospishel	Barton	20 & 21-17S.-15W.	3,573	6-30-39	Arbuckle	Surface
13. Prusa North	Barton	NW.¼ 17 & E.½ 18-16S.-11W.	3,327	9-11-39	Arbuckle	X. A.
14. Prusa West	Barton	W.½ 18-16S.-11W.	3,217	6-30-39	Oswald	X. A.
15. Trapp West	Russell	15-15S.-14W.	3,253	7-13-39	Arbuckle	Subsurface
16. Van Patton	Norton	26- 4S.-21W.	3,495	5-13-39	Oswald	Unknown
		GAS FIELDS				
1. Prusa	Barton	17-16S.-11W.	3,142	2-27-39	Oswald	Surface
2. Goodland	Sherman	27 & 30- 8S.-39W.	1,100	3-22-39	Smoky Hill Chalk	Unknown
		1939 OIL FIELDS EAST OF RANGE 2 EAST				
1. Darien	Cowley	33-30S.- 4E.	3,286	6-26-39	Arbuckle	Subsurface
2. Ferrell	Butler	21 & 28-28S.- 8E.	2,690	3- 8-39	Mississippian "lime"	Surface
3. Rahn	Cowley	12-34S.- 5E.	2,953	10-17-39	Bartlesville	Unknown

X. A.—Expiring acreage.
Names used above have been adopted by the nomenclature committee of the Kansas Geological Society and the Mid-Continent Oil and Gas Association.

pool in Norton County, which is shut in for lack of pipeline outlet, is the first in the county and the most northwesterly production in Kansas. East of it in Phillips County, production in the Bow Creek pool is small but is being sold to a new coöperative refinery at Phillipsburg. The Goodland gas discovery is of doubtful value at present. Gas has been reported in the Smoky Hill chalk from a number of wells in northwestern Kansas for many years and it is the producing formation of the undeveloped Wray gas field in Yuma County, Colorado, discovered in 1920. The Goodland discovery suggests that minor amounts of gas may be found in the Smoky Hill chalk over a broad area on the Great Plains.

The Pospishell and Kruckenberg pools in western Barton County, though unimportant in themselves, encourage exploration in a part of the county that has heretofore received little attention. The Darien pool in Cowley County is similar to the Hittle Arbuckle pool, which is south of it, but apparently less prolific and smaller in area. The Rahn discovery in T. 34 S., R. 5 E., will spur the search for more Burbank sand pools in Cowley County. The North Bornholdt pool in western McPherson County is probably an extension of the Bornholdt pool, which is discussed later. The Cairo oil discovery is due to deepening of an old gas well.

All other discoveries are on the Central Kansas uplift and probably all will eventually prove to be extensions of old fields

DEVELOPMENT

So much of the development of Kansas reserves in 1939 was routine that few important highlights stand out. Due to approaching expiration of many leases, wells were drilled that otherwise would not have been. The result was an unusually high percentage of dry holes in some areas, but also the extension of many old pools and the joining of others. Most of the activity was concentrated in Ellis, Russell, Barton, Ellsworth, and Rice counties, due to low development costs and shallower depths.

Burnett pool.—Drilling in T. 11 S., Rs. 17 and 18 W., connected the Burnett, South Burnett, and Peavey pools and established a continuous producing area of more than 2,750 acres with the limits of the pool undefined on all sides. Prolific Arbuckle dolomite production was assured by the completion of 51 wells with a potential of 145,850 barrels at the turn of the year. Lansing-Kansas City (Oswald) limestone production was established in one well. This field will be developed almost wholly on a 20-acre spacing.

Bemis-Shutts.—Extension of the Bemis pool east and south had

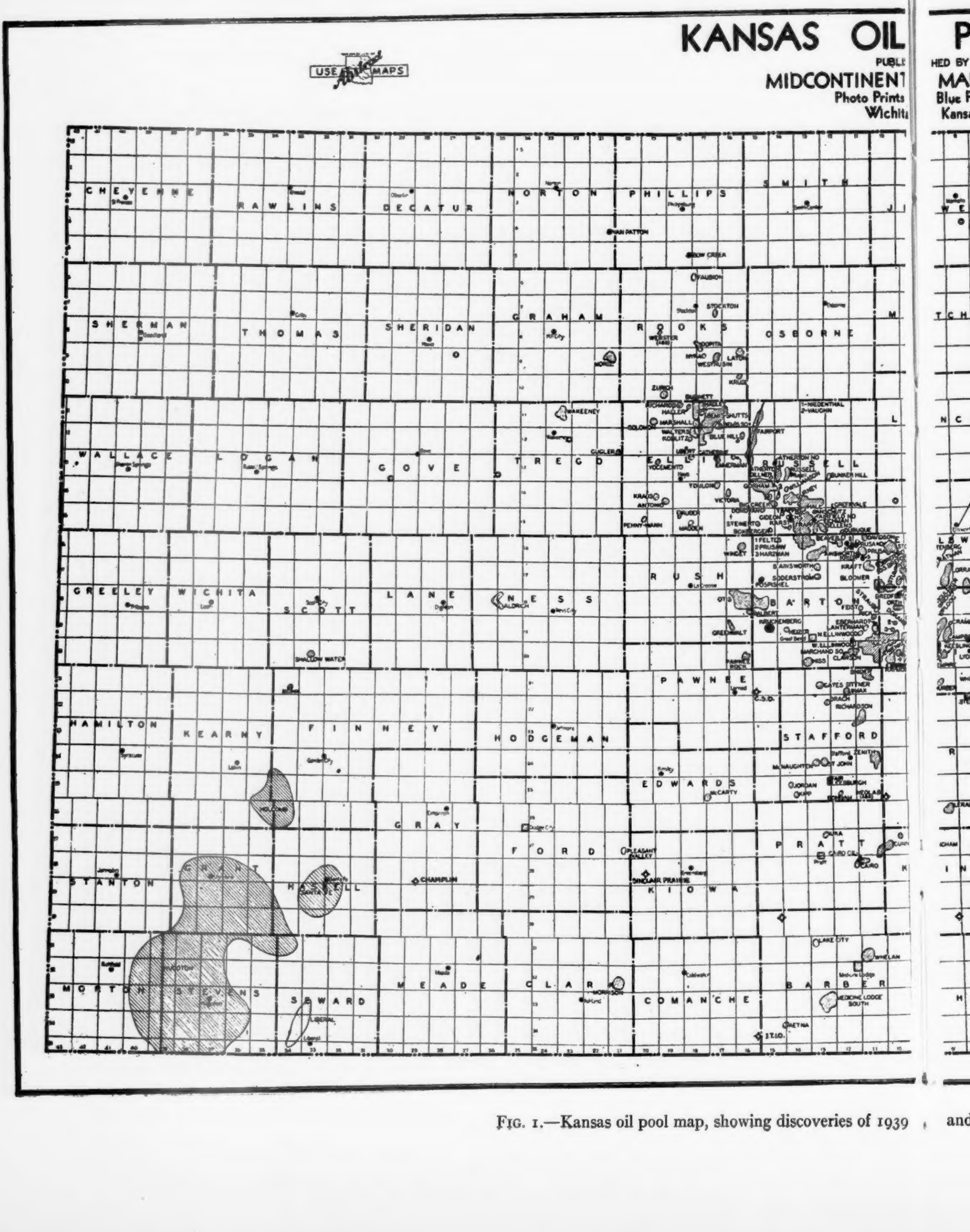
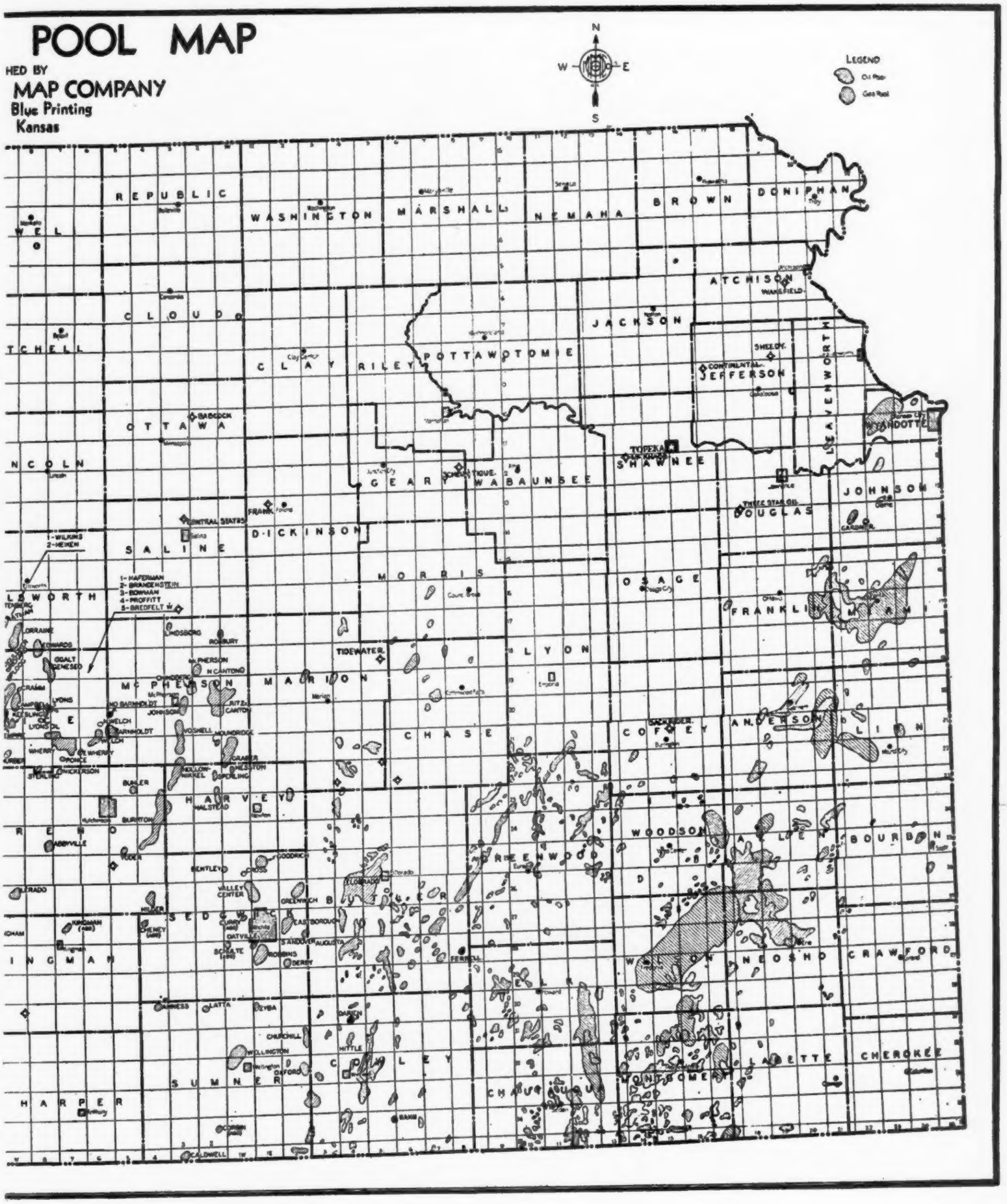


FIG. 1.—Kansas oil pool map, showing discoveries of 1939 and



and more important dry holes completed in 1939.

proceeded sufficiently far at the end of the year to assure its connection with the Cress and Shutts pools and the area hereafter is to be known as the Bemis-Shutts pool. Prolific production in Arbuckle dolomite has been established in much of T. 11 S., Rs. 16 W. and 17 W., and T. 12 S., R. 17 W. Three hundred six wells had a potential of 703,835 barrels.

Russell County development.—Arbuckle limestone development in the Trapp pool and adjacent areas was decidedly successful and resulted in the incorporation of outlying areas with that pool. Similarly, completion of profitable wells in the Gurney, Hall, and Letsch pools and near-by areas has given southern-central Russell County a strip of producing territory 15 miles long and several miles wide in places. Most of the production here is in the Lansing-Kansas City limestone.

Prusa pool.—T. 16 S., R. 11 W., was the scene of much activity. Discovery of four new pools, which will probably eventually be considered in the Prusa pool, was the fruit of a drilling campaign brought on by lease expirations.

Bornholdt pool.—One of the surprises of the year was the development in T. 20 S., Rs. 5 and 6 W., of prolific production at the top of Mississippian residual chert. The discovery well of the Bornholdt pool had been completed in 1938 as a small well. Again expiration of near-by leases caused development to spread, the producing area being extended in all directions by flowing wells. In the last month of the year, the discovery well of what is now called the North Bornholdt pool was drilled in and later completed for a maximum allowed potential of 3,000 barrels. It really represents a 2½-mile extension of the Bornholdt pool and is the forerunner of a steady drilling campaign covering several sections. Twenty-acre spacing is customary in this field and profits should be high as recoveries may be expected to be higher than in most "chat" fields.

Wherry pool.—The Wherry pool, centering in T. 21 S., R. 7 W., Rice County, was extended both northwest and southeast during the year. Many inside wells were also drilled, but water appeared in some of the edge wells. The Sooy conglomerate at the base of the Pennsylvanian is the producing formation.

Zenith pool.—Development of the Zenith pool continued throughout the year at a steady pace and production in the "Misener zone" and Viola limestone was extended east, north, and west. Erratic subsurface conditions were uncovered by drilling, but the size of the wells appeared to warrant a steady drilling program. It is in T. 24 S., R. 11 W., Stafford County.

Hittle pool.—The most active drilling campaign in a small area

was experienced in the Hittle pool in T. 31 S., R. 4 E., Cowley County. Flush production from the Arbuckle dolomite in Sections 21 and 28 covers about 900 acres. Several wells had potentials in excess of 10,000 barrels per day, but at the close of the year production was declining rapidly despite proration. Recoveries of individual wells or leases may be unusually high.

MISSOURI

Forty-one wells are known to have been drilled in Missouri in 1939, but of these eighteen failed to reach Mississippian rocks. Most of the latter tests were wells in Platte and Clay counties drilled to Pennsylvanian sands for gas. Twenty-three wells were drilled to horizons sufficiently deep to be considered "deep tests." The stratigraphic horizon reached by these is as follows:

Pre-Cambrian	1
Arbuckle dolomite (Cambro-Ordovician)	16
Upper and Middle Ordovician	3
Devonian	2
Mississippian	1

The locations of all important Forest City basin dry holes, as well as those completed in outlying areas, are shown by conventional symbols of Figure 2. Drilling well symbols represent wells being drilled at the end of the year, many of which have since been abandoned in 1940. The location of the Nebraska discovery well is also shown.

A number of tests drilled along the Lincoln fold and elsewhere in north-central Missouri are not in the Forest City basin, but were generally considered as basin tests by the oil fraternity.

The most intensive area of exploration was in a trend running from Kansas City north and west to Mound City, Missouri. In this area nine wells were completed, all but two of which reached Arbuckle dolomite. These wells and a handful of wells in northeast Kansas confirmed the structural shape of the basin, and furnished much valuable stratigraphic detail. Although showings of oil and gas were found in Pennsylvanian sands, and the customary numerous rumors of oil in deep formations were reported, it can be confidently stated that not one showing of free oil was found in pre-Pennsylvanian rocks in any well drilled in Missouri in 1939.

Fourteen of the twenty-three deep tests were drilled on some type of surface structure, and several of the structural features described in the publications of the Missouri Bureau of Geology and Mines were tested. It must be mentioned that due to glacial cover outcrops of bed rock are scarce in Missouri, and the attitude of the Pennsylvanian beds can be but imperfectly determined. In order to fully portray the

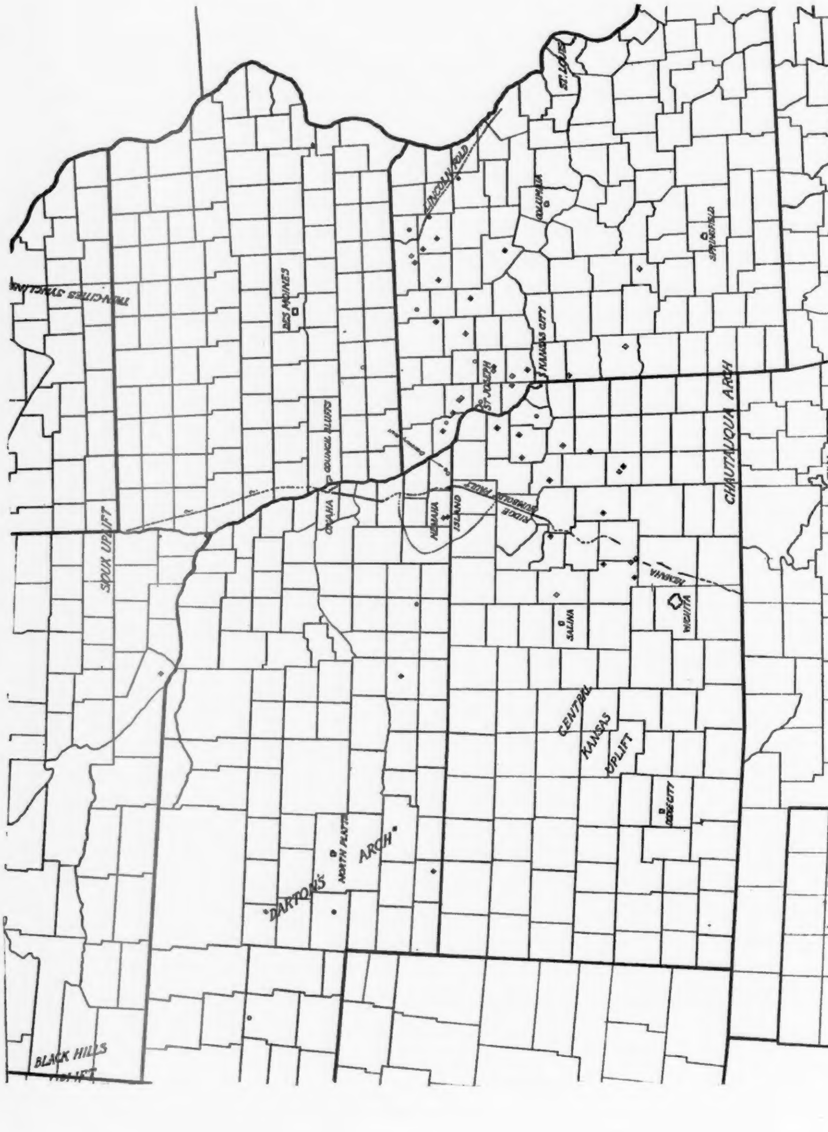


FIG. 2.—North Mid-Continent region showing location of important wells drilled in Forest City basin and adjacent areas in 1939.

true structural picture, core drilling should have been employed in many areas; moreover, in some areas the results of drilling on surface structures suggest that the attitude of beds of Kansas City and Marmaton age are poor indicators of pre-Pennsylvanian structure. Although results have been definitely discouraging, the failure of these structural irregularities to produce should not be considered a true measure of the oil and gas possibilities of pre-Pennsylvanian rocks.

At the beginning of 1940 a dozen test wells were in various stages of drilling in Missouri, and another dozen are proposed. A summary of deep wildcat drilling in Missouri is given in Table V.

TABLE V

DEEP WILDCATS IN MISSOURI, 1939

Section-Township-Range	*County*	*Feet Total Depth*	*Formation*	*Operator*	*Method*
2-37 N.-21 W.	Hickory	1,642	Pre-Cambrian	A. M. Sims	Chance
11-39 N.-30 W.	Bates	1,446	Arbuckle	Monarch Royalty	Unknown
4-45 N.-33 W.	Cass	1,500	Arbuckle	C. C. Lewis	Surface
36-52 N.-32 W.	Clay	1,680	Arbuckle	Frank Hopper	Surface
35-53 N.-18 W.	Charitan	936	Arbuckle	Buttram Petro.	Unknown
28-53 N.-32 W.	Clay	1,850	Arbuckle	Eastern Drlg.	Surface
20-53 N.-33 W.	Platte	1,857	Arbuckle	Turner *et al.*	Surface
18-55 N.-31 W.	Clinton	1,829	Viola	C. E. King *et al.*	Surface
13-55 N.-32 W.	Clinton	1,886	Arbuckle	C. E. King	Surface
22-58 N.-23 W.	Livingston	1,225	Simpson	Davis Bros.	Surface
27-59 N.- 9 W.	Shelby	650	Devonian	Wright & Turner	Unknown
29-59 N.-27 W.	Davies	770	Miss.	Dr. Francis	Unknown
28-60 N.-35 W.	Andrew	2,750	Arbuckle	Davis Bros.	Surface
34-60 N.-35 W.	Andrew	2,200	Devonian	Jones & Hyde	Chance
12-60 N.-37 W.	Andrew	2,744	Arbuckle	E. F. Neely	Surface
18-62 N.-15 W.	Adair	1,623	Arbuckle	Ward McGinnis	Surface
12-62 N.-21 W.	Sullivan	1,740	Arbuckle	Lario	Surface
3-62 N.-26 W.	Harrison	1,907	Arbuckle	Ward McGinnis	Surface
30-62 N.-38 W.	Holt	2,862	Maquoketa	Lewis *et al.*	Chance
20-63 N.-13 W.	Adair	1,431	Arbuckle	Mayson Oil	Chance
33-64 N.-17 W.	Schuyler	1,526	Arbuckle	Morror & Rogers	Chance
14-65 N.-18 W.	Putnam	1,688	Arbuckle	Slater & Phillips	Surface
26-65 N.-19 W.	Putnam	1,779	Arbuckle	C. E. Ditman	Surface

The structural relationships of the deeper part of the basin are shown in Figure 3 by a cross section from Dubois, Nebraska, eastward to the vicinity of Savannah, Missouri, thence southeastward to Liberty, Missouri. The position and relative importance of the Humboldt fault on the east side of the Nemaha granite ridge stands out. The divergence of the interval betweeen the base of the Kansas City group, and the top of the Meramec group, as well as the thickening of the Kinderhook shale and the Siluro-Devonian limestones and dolomites in a northwestward direction illustrate the location of the Forest City basin. Nearly all of the information shown on the cross

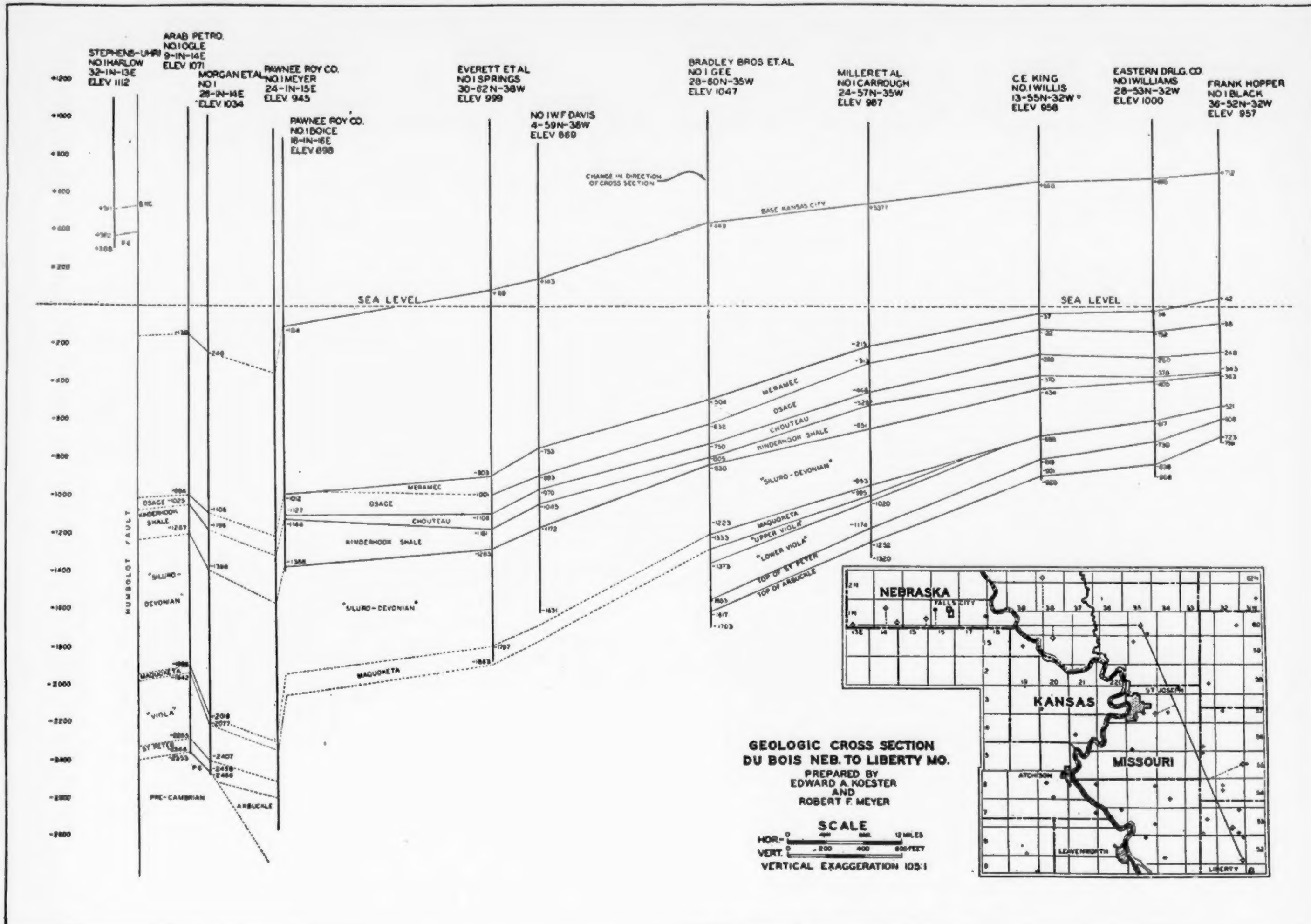


FIG. 3.—Geologic cross section from DuBois, Nebraska, to Liberty, Missouri.

section is derived from sample examination, but inasmuch as samples have not been released on the Pawnee Royalty Company, No. 1 Meyer in Sec. 24, T. 1 N., R. 15 E., the interpretation of the log of that well as shown in the cross section is based on incomplete scout information. However, the structural position of this well is believed to be essentially correct.

NEBRASKA

The only encouraging result of the Forest City basin play was the discovery of oil in the Pawnee Royalty Company's Boice No. 1 in Sec. 18, T. 1 N., R. 16 E., Pawnee County, Nebraska. This well found a showing of oil November 1st in a "pay" at 2,276–2,281 feet, which has since been determined as the top of a Devonian dolomite believed to be correlative to the Hunton group of Oklahoma and Kansas. This well filled up and slopped over at the rate of $\frac{3}{4}$ barrel per hour in 72 hours. Subsequently, it was placed on production in an attempt to establish production of 50 barrels or more per day for a 60-day period which would be sufficient to qualify for a bonus of $15,000 offered by the State of Nebraska. When production declined to less than 50 barrels per day the well was deepened and acidized, and considerable water was produced with the oil. After several unsuccessful attempts to shut off water, the well is being deepened to test lower formations.

While the Boice well was being tested the Pawnee Royalty Company commenced their Meyer No. 1 in Sec. 24, T. 1 N., R. 15 E., as a mystery well. Information is difficult to secure on this well, but it indicates that the test has been abandoned at a total depth of slightly more than 3,700 feet. As shown on the accompanying cross section the Meyer well is reported to be about 185 feet lower than the Boice well on the top of the Devonian dolomite. The Meyer well is supposed to have found a full section of pre-Pennsylvanian beds, and to have been abandoned in Arbuckle dolomite.

If the foregoing information is essentially correct it indicates that the Boice discovery well is on a relatively steep subsurface "high," the location of which is reported to be mappable on scattered outcrops. Some geologists have suggested that the accumulation of oil in the Boice well in the Devonian beds is controlled by a stratigraphic trap. Accumulation of oil in the Hunton group in Kansas is generally associated with a stratigraphic trap.

Six important dry holes were completed in Nebraska in 1939, none of which is in the Forest City basin. One of the most important tests was that of C. L. Price and Associates' Carter No. 1, Sec. 35, T. 2 N., R. 32 W., Hitchcock County, which was completed at 4,464 feet. It

FIG. 3.—Geologic cross section from DuBois, Nebraska, to Liberty, Missouri.

found the top of the Dakota group at 1,615 feet, Morrison at 2,230 feet, and Permian redbeds at 2,265 (?) feet. From 3,380 feet to 4,235 feet, the section is interbedded limestone and shale, largely red, which is not readily correlated with the Permo-Pennsylvanian rocks of central and eastern Kansas, but which no doubt includes beds as old as Lansing-Kansas City. The section from 4,235 feet to 4,320 feet seems to represent the Sooy conglomerate of the Kansas subsurface in its broader definition, although older beds may be represented in the lower 25 feet, which is cherty and sandy. A highly glauconitic sandy dolomite section is found to 4,440 feet, below which is well rounded, coarse sand, overlying, at 4,459 feet, weathered biotite granite. The dolomite and sand section is considered to be the Cambrian part of the Arbuckle group.

The failure of this test to produce and the character of the pre-Pennsylvanian section are discouraging to exploration in this part of the state, but may represent only local conditions. The Cambrian part of the Arbuckle has been relatively unproductive where drilled on the Central Kansas uplift. However younger Cambro-Ordovician beds are found above it within a short distance and are there highly productive. Such conditions may be duplicated in Nebraska. Nevertheless, results such as found in the Carter well are certain to discourage development. Dead asphaltic stain in partially porous limestone at 3,677–3,700 feet and another stained zone at 3,855–3,860 feet are the only encouraging showings reported. The coarsely oölitic, porous zones of the Lansing and Kansas City groups which produce on the Central Kansas uplift are missing in this well.

Condra[3] has mentioned a "high" extending southeastward from the Chadron dome toward the Cambridge anticline of south-central Nebraska. The Carter well is on the southwest flank of this "high" which has been mapped as a Dakota "high" by N. H. Darton,[4] and is often referred to as "Darton's arch." The presence of this structural feature as a positive element for a long time has been verified in the last few years by several wells: Byrd-Frost and Magnolia Petroleum Company's Abbott No. 1, Sec. 22, T. 24 N., R. 38 W., Grant County, which found pre-Cambrian at 4,008 feet; Helmerich and Payne's Hanson No. 1, Sec. 24, T. 15 N., R. 31 W., Lincoln County, which found granite at 3,803 feet; and Red Willow Oil and Gas Company's Cambridge No. 1, Sec. 13, T. 5 N., R. 26 W., Frontier County, which found granite at 3,360 feet.

[3] G. F. Condra, "Deep Wells in Nebraska," *Nebraska Geol. Survey Bull. 4* (1931), p. 17.

[4] N. H. Darton, "Geology and Underground Water Resources of the Central Great Plains," *U. S. Geol. Survey Prof. Paper 32* (1905).

West of the Humboldt fault Blazier and McClure completed a well in Sec. 16, T. 1 N., R. 10 E., Pawnee County, at 801 feet in the Pennsylvanian. Stevens and Uhri completed a well in Sec. 32, T. 1 N., R. 13 E., Richardson County, at 804 feet in pre-Cambrian granite, and Droge *et al.* had a dry hole in Sec. 34, T. 2 N., R. 10 E., Pawnee County, at 927 feet in pre-Cambrian granite. An important test in Adams County was that of Prunty *et al.* in Sec. 26, T. 7 N., R. 10 W., which was abandoned at 4,005 feet in Arbuckle dolomite of Ordovician age. In Dawes County Broadmoor Oil Company completed a test in Sec. 1, T. 33 N., R. 50 W., at about 3,000 feet, apparently in beds of Morrison age.

IOWA

The basin part of Iowa was extensively leased in 1939, and several tests were proposed, but none was completed. In Muscatine County Roy C. Smith *et al.* completed an oil test at 1,270 feet in Sec. 29, T. 76 N., R. 4 W., near Conesville. In Union County, Phillips Petroleum Company commenced Creston No. 1 in Sec. 31, T. 71 N., R. 30 W., and completed it in April, 1940. This well may have found the base of the Pennsylvanian and top of the Ste. Genevieve sand at 1,140 feet, going into the St. Louis limestone at 1,171 feet. The base of the Mississippian limestone was found at 1,543 feet, and the top of the Devonian limestone-dolomite at 1,595 feet. From this depth to 2,298 feet a section of limestone, dolomite, gypsum, and gypsiferous dolomite was found, as well as a sandy, cherty dolomite in the lower 50 feet of the sequence. The underlying Maquoketa is followed by a long section of Upper and Middle Ordovician beds. St. Peter sand was found between 2,759 and 2,789 feet. Between the latter depth and 2,860 feet, the total depth, porous and vugular dolomite of Canadian age was found. The Creston well found a stratigraphic section similar to the Clarinda and Bedford wells, but supplied a much better set of samples.

SOUTH DAKOTA

In Charles Mix County, J. E. Palinsky drilled a well into pre-Cambrian in Sec. 15, T. 95 N., R. 64 W., to 5,050 feet. It is reported this well is being deepened.

In the southeast corner of the state, Sioux Valley Oil and Gas Company's Le Fleur No. 1 in Sec. 18, T. 90 N., R. 48 W., Union County, was drilled to 1,180 feet. This well furnished much valuable information concerning the pre-Quaternary stratigraphy of the region around the Sioux uplift. Cretaceous beds probably correlative with the Dakota group are found under the Quaternary at 245–390 feet,

and overlie Siluro-Devonian dolomite, the base of which was found at 518 feet. Between that depth and 765 feet Upper and Middle Ordovician beds probably correlative with northeast Iowa are found. Forty feet of St. Peter sand extends to 805 feet. From this depth to 1,028 feet, the top of Sioux quartzite, the section is interpreted as Cambrian. Beds of Canadian age are not believed to be present in this well.

ACKNOWLEDGMENTS

The writers acknowledge the assistance and advice of the many geologists who have aided in the preparation of this summary, especially that of Anthony Folger, Harold O. Smedley, H. S. McQueen, and E. C. Reed.

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VOL. 24, NO. 6 (JUNE, 1940), PP. 1011-1024, 1 FIG.

DEVELOPMENTS IN OKLAHOMA DURING 1939[1]

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ABSTRACT

The history of development in Oklahoma during 1939 was in many ways a repetition of the preceding year.

Total production of oil for the state during the period was 153,500,000 barrels, a decrease of 9.7 per cent from the total of 170 million barrels withdrawn during 1938. With a total 2,065 wells completed during 1939, drilling operations were slightly above the preceding year. Well completions were rather widely distributed throughout the pools of the state, with no concentration of development in any particular area other than the usual preponderance of drilling in the general Seminole plateau province.

The Oklahoma City and Fitts pools continued to lead the state in total annual field output.

There was little change in the amount of geophysical exploration work being carried on throughout the state, but in contrast to the policy of the preceding year, operations were confined largely to outlying wildcat areas.

The number of wells which might be considered as wildcat or exploratory tests increased somewhat during the year. Of the total of 2,065 completions, 268, or 13 per cent, have been here classified as exploratory wells. As a result of this comparatively large number of extension and wildcat tests, 31 new pools and 29 extensions and new zones were discovered and several rather important outlying dry holes drilled. Of the 60 new discoveries, 35 were in Pennsylvanian sediments, 11 in Siluro-Devonian, and 14 in the Ordovician. Few of the new pools were of general importance and none was conspicuous for extensive development during the year. The most important discoveries were perhaps the Hobart pool, in Washita County, the Byars pool, in McClain County, and the Arbuckle zone, in the Frederick pool, Tillman County. The Pure Oil Company's Little well No. 1 in the Cumberland area, Marshall County, which was not completed until March, 1940, and is not included among the 1939 discoveries, may have opened one of the most important new areas discovered in the past 5 or 6 years.

While numerically impressive, the new discoveries during 1939 did not add greatly to the Oklahoma total reserves. As in the several preceding years the annual withdrawal exceeded the estimated total of the newly discovered reserves by many millions of barrels. The faith of the wildcatter in Oklahoma's future is, however, still strong and the year closed with many outlying test wells either actively drilling or in immediate prospect of being drilled.

INTRODUCTION

A review of activities in the petroleum industry in Oklahoma during 1939 reflects a slight increase in drilling operations, particularly in exploratory wells seeking to discover new reserves. As a result of this intensified effort the number of new pools and extensions added during the year was somewhat greater than the number recorded for 1938. There was little noticeable change in the amount of geological and geophysical work being done in advance of drilling, although exploratory efforts were extended into areas more remote from producing pools. In spite of the increased number of new pools and extensions opened during the year, none has been proved of major importance, and the total production for the state was less by 16,500,000

[1] Manuscript received, May 23, 1940.

[2] Geologist, Stanolind Oil and Gas Company.

barrels than the withdrawals for the preceding year. About half of the decrease may be attributed to the state-wide 15-day shut down during the month of August.

PRODUCTION

Total production of oil in Oklahoma during 1939 was 153,500,000 barrels, a decrease of 16,500,000 barrels or 9.7 per cent from the total for 1938. All of the major producing pools participated in the general decline with the exception of the St. Louis-Maud area. Due to the large number of extensions developed during the year in this area, combined with successful deepening and plug-back operations, there was an increase in annual production from 7,780,000 barrels in 1938 to 11,580,000 barrels during 1939. The Oklahoma City pool which still led the state in output, declined from 38,796,000 barrels in 1938 to 35,728,000 barrels during the past year. The Fitts pool which had ranked second in the state during 1938, with a total output of 16,655,000 barrels, declined to 9,120,000 during 1939. No other individual pools in the state exceeded a total production of 4 million barrels for the year.

DRILLING OPERATIONS

The number and general classification of well completions in Oklahoma during 1939 are shown in Table I.

TABLE I

COMPLETIONS IN OKLAHOMA DURING 1939

	Total Completions			
	Total Number	*Oil*	*Gas*	*Dry*
Number	2,065	1,257	109	699
Percentage of total		60.9	5.3	33.8

	Pool Wells				*Wildcat and Extension Wells*			
	Total Number	*Oil*	*Gas*	*Dry*	*Total Number*	*Oil*	*Gas*	*Dry*
	1,797	1,208	98	491	268	49	11	208
Percentage of total	(87*)	67.2	5.5	27.3	(13*)	18.3	4.1.	77.6

* Percentage of total completions.

In spite of the slight indicated increase in total completions for the year, drilling operations were rather widely scattered. There was no conspicuous development in any pool. A few completions here and there throughout the many pools both old and new in the central Oklahoma producing belt accounted for most of the new wells. The limits of production were defined in the majority of pools discovered

prior to 1939 and further drilling operations terminated thereby. The Ramsey pool in Payne County, one of the major discoveries during 1938, has been practically defined with the completion of 39 producing wells and 5 dry holes. The Coyle pool, also in Payne County, with 25 producers and 3 dry holes, is defined except on the south and west. None of the new areas discovered during 1939 has indicated sufficient magnitude to encourage the drilling of more than 8 or 10 wells.

EXPLORATION AND DISCOVERIES

There was no appreciable change in the number of geophysical crews operating in Oklahoma during the year, but there was a change in the general nature of the exploratory work as contrasted to activities during the previous year. Whereas exploration during 1938 was largely confined to close detail work in areas adjacent to producing fields the greater number of geophysical units operating during 1939 were engaged in mapping wildcat areas remote from known productive trends. Table II shows the general distribution of geophysical operations in Oklahoma during the year.

TABLE II

GENERAL DISTRIBUTION
GEOPHYSICAL OPERATIONS IN OKLAHOMA
DURING 1939

Instruments	*Week Ending 1-27-39*	*Week Ending 6-23-39*	*Week Ending 1-27-40*
Seismographs, total number	18	17	15
Number east of Indian Meridian	5	4	3
Number west of Indian Meridian	13	13	12
Torsion balances, total number	—	1	—
Number east of Indian Meridian	—	—	—
Number west of Indian Meridian	—	1	—
Gravity meters, total number	3	5	4
East of Indian Meridian	—	2	—
West of Indian Meridian	3	3	4
Magnetometers, total number	—	—	4
East of Indian Meridian	—	—	—
West of Indian Meridian	—	—	4
Total number instruments	21	23	23
East of Indian Meridian	5	6	3
West of Indian Meridian	16	17	20

In addition to the geophysical units listed in Table II there were a number of geochemical surveys and some core-drill operations reported from various areas within the state.

In the effort to discover new fields and to extend the limits of old producing areas, 268 wildcat or extension test wells were drilled in Oklahoma during 1939. This total amounts to 13 per cent of all completions for the year as compared with a ratio of 11 per cent during

1938. The exploratory wells were scattered over 51 of the 77 counties of the state. Total footage penetrated by the 268 wells was approximately 916,000 feet, or an average of 3,418 feet per well. Table III shows the comparative results of exploratory work in the ten leading counties in which the wildcatter was most active.

TABLE III

DISTRIBUTION OF EXPLORATORY TEST WELLS IN 1939 FOR TEN LEADING COUNTIES IN OKLAHOMA

County	*Total Wildcats**	*Oil*	*Gas*	*Dry*	*Total Footage*
Seminole	29	11	—	18	101,899
Pottawatomie	24	8	—	16	107,781
Creek	16	5	1	10	49,256
Lincoln	15	2	—	13	61,650
Hughes	13	3	2	8	34,269
Wagoner	13	—	—	13	11,329
Osage	10	2	—	8	23,032
Pontotoc	10	1	—	9	18,124
Kiowa	10	1	—	9	12,557
Okfuskee	9	3	1	5	29,119
Total	149	36	4	109	449,016
Average footage per well					3,013

* Includes extension tests and deepening and plugging-back operations.

A study of Table III reveals that more than 50 per cent of the total exploratory wells drilled during the year were located in the 10 counties. A detail check of the complete list of wildcat and extension wells brings to light another interesting fact. Of the total of 268 wells, 237 or 88.4 per cent were drilled by independent operators and only 31 by major companies. Thus, while by far the greater part of geophysical and geological exploratory work is conducted by the large oil-producing corporations, the individual and the small company are still the pioneers in the actual drilling of wildcat wells.

In view of the present general tendency on the part of the major operators to check and recheck prospective oil territory by several geological and geophysical methods and to farm out to individuals or smaller companies all but the best acreage blocks, any attempt to attribute new discoveries and dry holes to any particular type of work is almost meaningless, without an intimate knowledge of the various influences which might have led to the drilling of the well.

As a result of drilling 268 exploratory wells during 1939, 31 new pools and 29 extensions to old pools were discovered. In Table IV are listed the wells which are considered as discovery or extension wells, with classification, location, and other pertinent data.

On the map of Oklahoma (Fig. 1) are indicated the location and name of new pools discovered during the year. A few of the more

TABLE IV

NEW POOLS, EXTENSIONS, AND NEW ZONES DISCOVERED IN OKLAHOMA DURING 1939

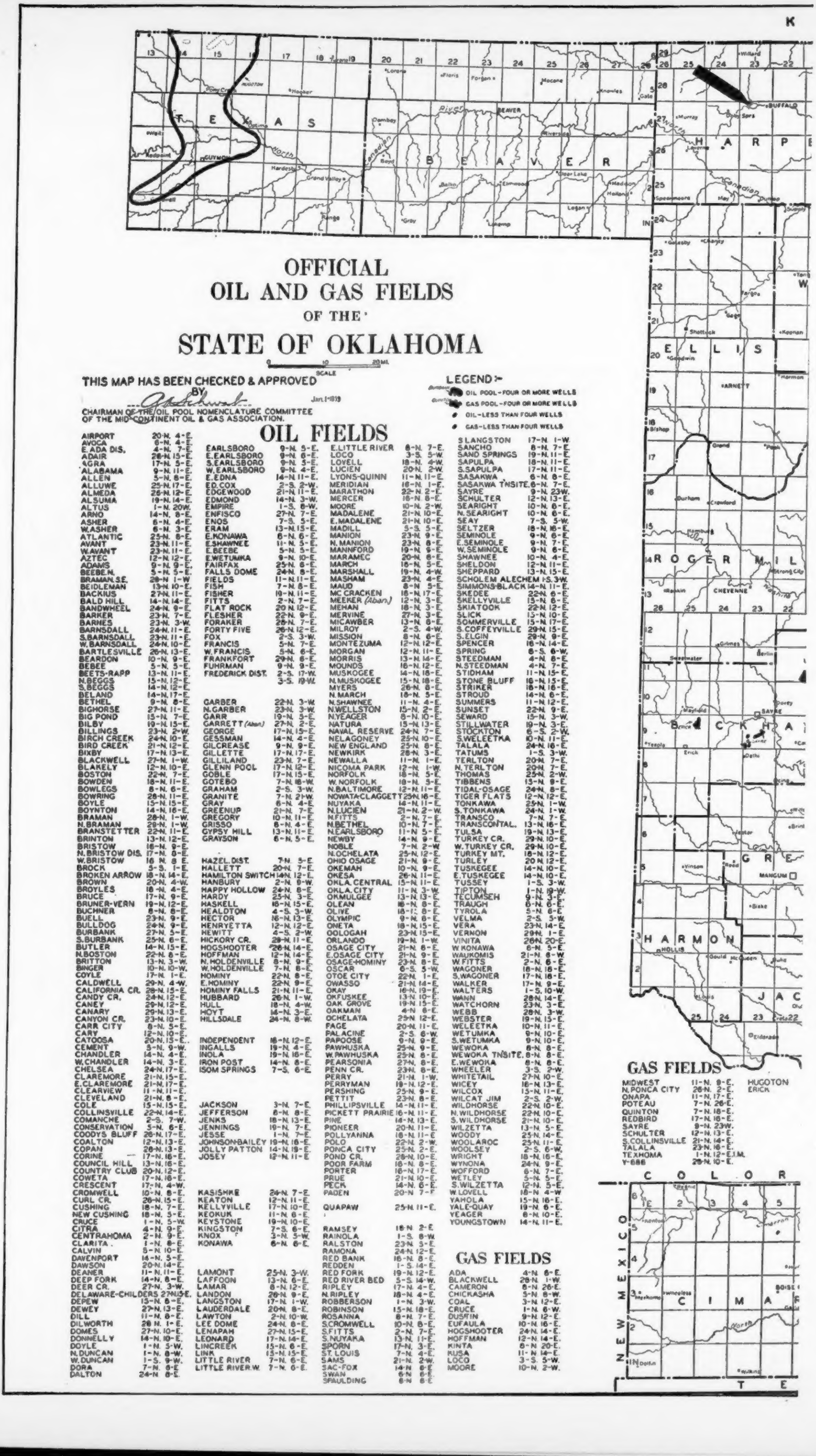
County	*Field*	*Class*	*Sec. T-R*	*Operator*	*Well*	*Date of Completion*	*Producing Sand*	*Feet Total Depth*	*Initial Production*	*Development*
Carter	Noble	New	35-3S-1E	Pure Oil Co.	Noble 1	8-11-39	Woodford	8,500 4,454 PB	P-140	1 well
Cleveland	Norman	New	17-9N-2W	Burton & Rucker	Norman 1	1939	Simpson	7,695 7,540–50 Perf.	P-125 oil 19 wtr.	2 wells
Creek	Lafoon	New	30-14N-7E	Burke Greis	Vanderslice	4-21-39	Prue	2,884	4 M gas	1 well
	E. Walker	New	11-17N-9E	Hoels Brukens		5- 5-39	Oswego	1,940	P-15 bbls.	2 wells
	22-18N-9E	New	22-18N-9E	Bryan Petr.	Johnson	8- 2-39	"Wilcox"	3,128	50 bbls. 5 wtr.	2 wells
	Kellyville	Ext.	32-18N-10E	Stekoll	George 2	Dec 1939	Prue	3,135 1,838 PB	P-6 bbls.	1 well
	N. Bristow	New	20-17N-9E	Strozier	Baker	6- 2-39	B'ville	2,545	100 bbls.	5 wells 3 dry holes
	Worley	New	34-14N-10E	Foundation Oil	Worley 1	7-21-39	"Wilcox" & Misener	3,295	365 bbls.	6 wells 1 dry hole
Garfield	Brown	Ext.	10-20N-4W	Hughes Drlg. Co.	Misener	4-28-39	2nd "Wilcox"	5,944	250 bbls.	1 well
Garvin	Davis	New	22-1N-1E	Kerlyn Oil	Butterly	5-19-39	Penn. sd.	5,005 3,085 PB	2.9 M gas	1 well
Grady	Chickasha	D.D.	26-5N-8W	Carter *et al.*	Smith	4-21-39	Deese	6,620 5,330 PB	13 M gas	2 wells
Hughes	N. Yeager	D.D.	5-8N-10E	Davon Oil	White	11-17-39	2nd "Wilcox"	3,875	Fl. 800 oil 100 wtr.	1 well
	Carson	New	5-8N-11E	T. J. Lynch	Bird	11- 3-39	Penn. sd.	1,562	½ M gas	1 well
	S.E. Sasakwa	New	23-6N-8E	Rogers	Scott	10-20-39	Booch	2,675	44 bbls.	2 wells 1 dry hole
	Citra	P.B.	33-4N-9E	Carter Oil	Hamilton	8-20-39	Cromwell	PF. 4,200–45	38 M gas	1 well
	Calvin	P.B.	8-5N-10E	Phillips Petr.	Shemwell	11-16-39	Cromwell	5,595	38 M gas & some oil	1 well
Kiowa	Hobart	New	20-7N-17W	Tarr, Gled, *et al.*	Watkins	5-15-39	Pontotoc or Viola	1,056	Fl. 616/6 hrs.	8 wells
Lincoln	S.E. Cushing	New	20-17N-6E	Murray & Griffey	Burke 1	10-31-39	Prue	2,908	25 oil & 3 M gas	1 well
	Skellyville	Ext.	8-15N-6E	Connelly	Selby 1	11-17-39	Hunton	3,988	7½ bbls. oil 7½ bbls. wtr.	1 well
Logan	Langston	D.D.	12-17N-1W	Sinclair-Prairie	Ford	10- 6-39	2nd "Wilcox"	5,152	440 bbls.	2 wells 1 dry hole
McClain	Byers	New	16-5N-3E	Patsy Oil	James 1	12-13-39	Viola-Sp.	3,623	1,080 bbls.	12 wells
McIntosh	Onapa	New	14-11N-16E	Pine	Marlin	10-18-39	Penn. sd.	2,372	4½ M gas	1 well
Muskogee	Muskogee	New	26-15N-17E	J. A. Wright	Morris	11-22-39	Penn. sd.	1,175	¾ M gas	1 well
Noble	S. Lucien	P.B.	34-20N-2W	Stano-Amerada	Sharp 2	7-13-39	Layton	3,975 PB	60 bbls.	Several wells
Okfuskee	W. Weleetka	New	18-10N-11E	Summit	Steil 1	7-14-39	Wapanucka ls.	3,812 2,980 PB	5 M gas	1 well
	W. Weleetka	New	18-10N-11E	Summit	Steil 2A	11-26-39	Booch sd.	2,179	240 bbls.	3 wells
	Micawber	New	6-13N-8E	Peters *et al.*	Woodson	1939	Prue	2,850 2,498 PB	P 25 oil 25 wtr.	1 well
	Weleetka	Ext.	16-10N-11E	Doak *et al.*	Community 1	9-27-39	Cromwell	2,841	50 bbls.	3 wells
Oklahoma	Newalla	New	30-11N-1E	Olsen	White	4-10-39	Hunton	6,638 6,095 PB	P 250 bbls. 20% wtr.	1 well
	Jones	New	28-13N-1E	Hall Briscoe	Thompson	10- 4-39	Cleveland	6,058 4,795 PB	P 105 oil 10 wtr.	2 wells
Osage	S. Hickory Cr.	New	10-28N-11E	Charles Pet.	Osage 1	6-21-39	Wayside	992	P 102 bbls.	Several wells
	E. Fairfax	New	26-25N-6E	I.T.I.O.	Osage	4-18-39	Skinner	2,931 2,757 PB	35 bbls.	1 well

TABLE IV—*Continued*

NEW POOLS, EXTENSIONS, AND NEW ZONES DISCOVERED IN OKLAHOMA DURING 1939

County	*Field*	*Class*	*Sec. T-R*	*Operator*	*Well*	*Date of Completion*	*Producing Sand*	*Feet Total Depth*	*Initial Production*	*Development*
Pawnee	Cleveland	New	5-20N-9E	Land Dev. Co.	Sills 1	6- 2-39	Prue	2,880 1,832 PB	4 M gas	3 wells
Payne	Broyles	D.D.	26-18N-4E	Mulberry Oil	Broyles 9	12-27-39	Wilcox	3,833	155 bbls.	1 well
	Cushing Lake	New	35-18N-4E	Starr Oil & Gas	Georgia 1	5- 9-39	Skinner	4,113 3,494 PB	½ M gas	2 wells
Pontotoc	West Bebee	New	27-5N-4E	Grosso Roy	Haskins	9-22-39	Hunton	2,639	P 25 bbls.	1 well
Pottawatomie	NW. St. Louis	New	28-8N-4E	Wood Oil	Peters	3-11-39	Hunton	4,560	P 88 oil 25 wtr.	1 well 1 dry hole
	SE. St. Louis	Ext.	4-6N-5E	Inglehart *et al.*	Keener	7-21-39	Sp. Dol.	4,071	1,650 bbls.	8 wells 2 dry holes
	Sacred Heart	New	19-6N-5E	Alma Oil	Johnson	5- 5-39	Earlsboro	4,062 3,019 PB	240 bbls.	10 wells 5 dry holes
	Pace	New	31-10N-5E	Geo. Pace	Hale	9-15-39	Viola	4,485	1,040 bbls.	1 well 1 dry hole
	Butcher	New	36-10N-4E	Butcher *et al.*	Mikish	10- 3-39	Hunton	4,532 4,265 Pf.	Fl. 1,090 bbls.	3 wells 2 dry holes
	St. Louis	D.D.	28-7N-4E	Phillaine	Garrett 3	9-24-39	2nd "Wilcox"	4,287	975 bbls.	
	E. St. Louis	Ext.	17-7N-5E	Kerlyn Oil Co.	Olsee	11- 8-39	Calvin	2,858	528 bbls.	2 wells 3 dry holes
	Maud	Ext.	21-8N-5E	Portable Drlg.	Eddy	1939	Hunton	4,265	P 15 bbls.	1 well
Seminole	Dora	Ext.	28-7N-6E	Smith	Billington	1-20-39	Calvin	2,858 Rp. Co. 2,276	F 106 bbls.	2 wells 3 dry holes
	E. Searight	Ext.	34-10N-6E	Moss	Leachman	11-24-39	Cromwell	4,630	Fl. 2,008 bbls.	2 wells 1 dry hole
	Swan	Ext.	17-6N-6E	Atlantic Ref.		1939	Simpson	4,023	P 33 oil & 164 wtr.	1 well
	Burton	Ext.	3-5N-5E	Culver & Shepherd	Burton-Swan	6-26-39	Hunton	2,668	Fl. 1,500 bbls.	7 wells 1 dry hole
	W. Wewoka	Ext.	25-8N-7E	J. A. Ligon	Logan	3-11-39	Cromwell	3,348	Fl. 400 bbls.	7 wells 1 dry hole
	South Fish	New	6-6N-8E	Eagle Oil	Ryan	9- 5-39	"Wilcox"	4,230	P 454 oil 120 wtr.	2 wells 1 dry hole
	Carter Cannon	P.B.	11-9N-6E	Addison	Werner	10- 6-39	Calvin	4,127 2,700 PB	30 oil & 1½ M gas	1 well
	Stout	D.D.	3-10N-5E	Geo. Deck	Newell	11-24-39	"Wilcox"	4,631	P 221	3 wells
	N. Allen	Ext.	30-6N-8E	Hall, Travis, Moore	White	4-28-39	Gilcrease	2,964 2,610 PB	P 64 bbls.	1 well 2 dry holes
	Mission	Ext.	18-8N-6E	J. C. Shaffer	J. Owens	7-14-39	Hunton	4,180 Fl.	100 bbls. in 1 hr.	1 well
	W. Seminole	Ext.	28-9N-6E	C. Martin *et al.*	Olivers	8-25-39	Calvin	3,100	P 50 oil & 350 wtr.	1 well
	Milroy	P.B.	24-2S-4W	Carter	Harley	11-39	Hunton	Pf. 4,845	1,900 bbls.	1 well
Stephens	W. Doyle	New	4-1N-5W	Phillips Pet.	Culbertson	4-12-39	Deese	5,619	1,071 bbls.	1 well
	Doyle	P.B.	12-1N-5W	Sunray Oil Co.	Hefner	10-12-39	Deese	Pf. 5,570	792 bbls.	2 wells
	Velma	Ext.	15-1S-5W	Carter & Burkhart	Spears 1	7-10-39	Shallow sds.	388	8 bbls.	Several wells gas and oil in sands to 750 ft.
Tillman	Frederick	D.D.	36-2S-19W	I.T.I.O.	Filmore	5-22-39	Arbuckle	5,135	P 147 oil 3 wtr.	4 wells 1 dry hole
						11-24-39		DD 5,165	F 1,300 oil 3% wtr.	

New: new pool. D.D.: deeper drilling. P.B.: plugged back. Ext.: extension.
P: pumped. Fl.: flowed.



OFFICIAL OIL AND GAS FIELDS OF THE STATE OF OKLAHOMA

SCALE 0 10 20 MI.

THIS MAP HAS BEEN CHECKED & APPROVED
BY
...G. A. Schwab... Jan. 1-1939
CHAIRMAN OF THE OIL POOL NOMENCLATURE COMMITTEE
OF THE MID-CONTINENT OIL & GAS ASSOCIATION.

LEGEND:-
OIL POOL - FOUR OR MORE WELLS
GAS POOL - FOUR OR MORE WELLS
OIL - LESS THAN FOUR WELLS
GAS - LESS THAN FOUR WELLS

OIL FIELDS

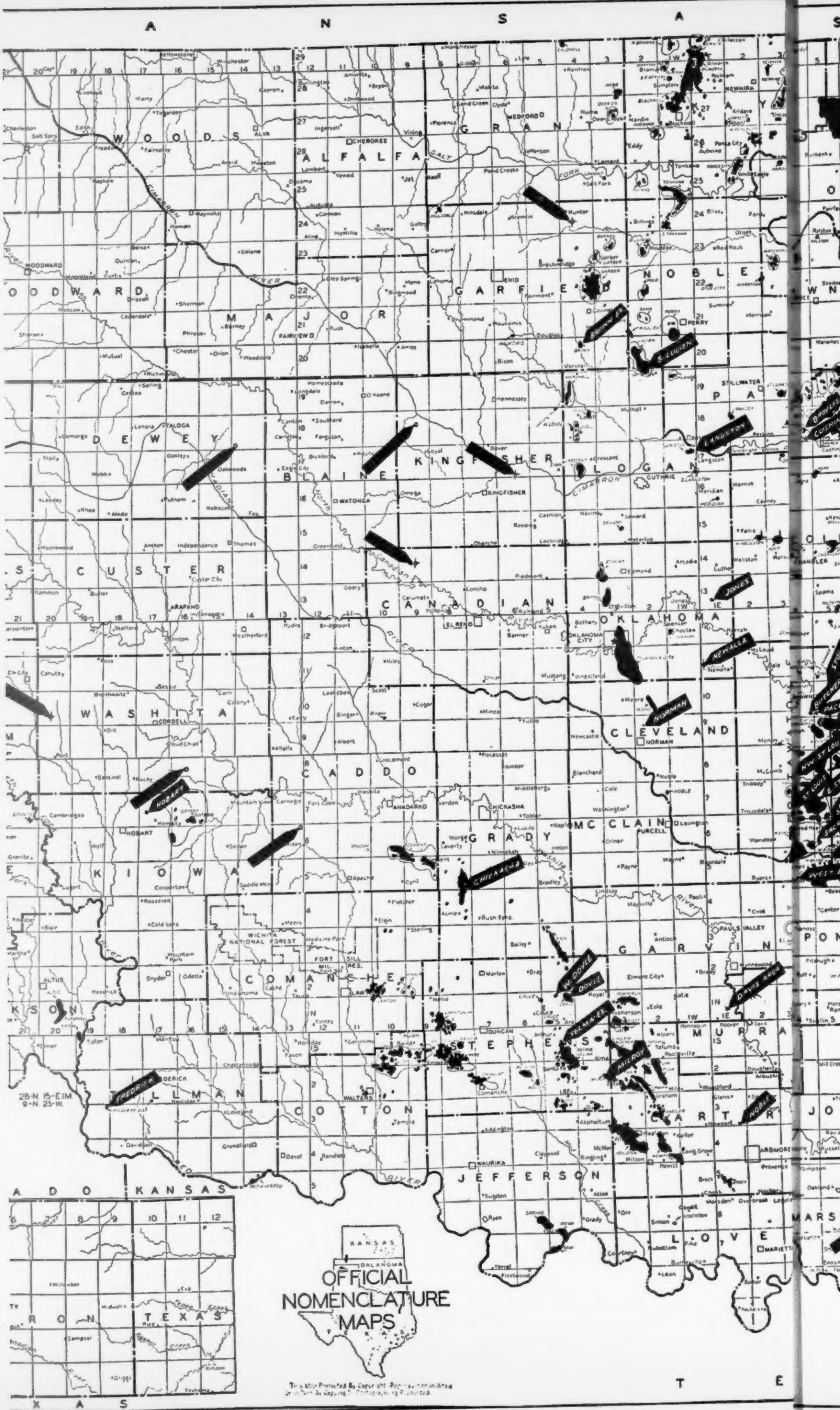
AIRPORT	20-N.	4-E.
AVOCA	6-N.	4-E.
E. ADA DIS.	4-N.	7-E.
ADAIR	28-N.	15-E.
AGRA	17-N.	5-E.
ALABAMA	9-N.	11-E.
ALLEN	5-N.	8-E.
ALLUWE	25-N.	17-E.
ALMEDA	26-N.	12-E.
ALSUMA	19-N.	14-E.
ALTUS	1-N.	20W.
ARNO	14-N.	8-E.
ASHER	6-N.	4-E.
W.ASHER	6-N.	3-E.
ATLANTIC	25-N.	8-E.
AVANT	23-N.	11-E.
W.AVANT	23-N.	11-E.
AZTEC	12-N.	12-E.
ADAMS	9-N.	9-E.
BEEBE N.	5-N.	5-E.
BRAMAN S.E.	28-N.	1-W.
BEIDLEMAN	13-N.	10-E.
BACKIUS	27-N.	11-E.
BALD HILL	14-N.	14-E.
BANDWHEEL	24-N.	9-E.
BARKER	23-N.	7-E.
BARNES	23-N.	3-W.
BARNSDALL	24-N.	11-E.
S.BARNSDALL	23-N.	11-E.
W. BARNSDALL	24-N.	10-E.
BARTLESVILLE	26-N.	13-E.
BEARDON	10-N.	9-E.
BEBEE	5-N.	5-E.
BEETS-RAPP	13-N.	11-E.
N.BEGGS	15-N.	12-E.
S.BEGGS	14-N.	12-E.
BELAND	14-N.	17-E.
BETHEL	9-N.	8-E.
BIGHORSE	27-N.	11-E.
BIG POND	15-N.	7-E.
BILBY	19-N.	15-E.
BILLINGS	23-N.	2-W.
BIRCH CREEK	24-N.	10-E.
BIRD CREEK	21-N.	12-E.
BIXBY	17-N.	13-E.
BLACKWELL	27-N.	1-W.
BLAKELY	12-N.	10-E.
BOSTON	22-N.	7-E.
BOWDEN	18-N.	11-E.
BOWLEGS	8-N.	6-E.
BOWRING	28-N.	11-E.
BOYLE	15-N.	15-E.
BOYNTON	14-N.	16-E.
BRAMAN	28-N.	1-W.
N.BRAMAN	29-N.	1-W.
BRANSTETTER	22-N.	11-E.
BRINTON	13-N.	12-E.
BRISTOW	16-N.	9-E.
N. BRISTOW DIS.	17-N.	8-E.
W.BRISTOW	16 N.	8 E.
BROCK	5-S.	1-E.
BROKEN ARROW	18-N.	14-E.
BROWN	20-N.	4-W.
BROYLES	18-N.	4-E.
BRUCE	17-N.	9-E.
BRUNER-VERN	19-N.	12-E.
BUCHNER	8-N.	8-E.
BUELL	23-N.	9-E.
BULLDOG	24-N.	9-E.
BURBANK	27-N.	5-E.
S.BURBANK	25-N.	6-E.
BUTLER	14-N.	15-E.
N.BOSTON	22-N.	8-E.
BRITTON	13-N.	3-W.
BINGER	10-N.	10-W.
COYLE	17-N.	1-E.
CALDWELL	29-N.	4-W.
CALIFORNIA CR.	28-N.	15-E.
CANDY CR.	24-N.	12-E.
CANEY	29-N.	12-E.
CANARY	29-N.	13-E.
CANYON CR.	23-N.	10-E.
CARR CITY	8-N.	5-E.
CARY	12-N.	10-E.
CATOOSA	20-N.	15-E.
CEMENT	5-N.	9-W.
CHANDLER	14-N.	4-E.
W.CHANDLER	14-N.	3-E.
CHELSEA	24-N.	17-E.
CLAREMORE	21-N.	15-E.
E.CLAREMORE	21-N.	17-E.
CLEARVIEW	11-N.	11-E.
CLEVELAND	21-N.	8-E.
COLE	15-N.	15-E.
COLLINSVILLE	22-N.	14-E.
COMANCHE	2-S.	7-W.
CONSERVATION	5-N.	6-E.
COODYS BLUFF	26-N.	17-E.
COALTON	12-N.	13-E.
COPAN	28-N.	13-E.
CORINE	17-N.	16-E.
COUNCIL HILL	13-N.	16-E.
COUNTRY CLUB	20-N.	12-E.
COWETA	17-N.	16-E.
CRESCENT	17-N.	4-W.
CROMWELL	10-N.	8-E.
CURL CR.	26-N.	15-E.
CUSHING	18-N.	7-E.
NEW CUSHING	18-N.	5-E.
CRUCE	1-N.	5-W.
CITRA	4-N.	9-E.
CENTRAHOMA	2-N.	9-E.
CLARITA	1-N.	8-E.
CALVIN	5-N.	10-E.
DAVENPORT	14-N.	5-E.
DAWSON	20-N.	14-E.
DEANER	11-N.	11-E.
DEEP FORK	14-N.	8-E.
DEER CR.	27-N.	3-W.
DELAWARE-CHILDERS	27-N.	15-E.
DEPEW	15-N.	8-E.
DEWEY	27-N.	13-E.
DILL	11-N.	8-E.
DILWORTH	28 N.	1-E.
DOMES	27-N.	10-E.
DONNELLY	14-N.	10-E.
DOYLE	1-N.	5-W.
N.DUNCAN	1-N.	8-W.
W. DUNCAN	1-S.	9-W.
DORA	7-N.	8-E.
DALTON	24-N.	8-E.
EARLSBORO	9-N.	5-E.
E.EARLSBORO	9-N.	6-E.
S.EARLSBORO	9-N.	5-E.
W.EARLSBORO	9-N.	4-E.
E.EDNA	14-N.	11-E.
ED.COX	2-S.	2-W.
EDGEWOOD	21-N.	11-E.
EDMOND	14-N.	3-W.
EMPIRE	1-S.	6-W.
ENFISCO	27-N.	7-E.
ENOS	7-S.	5-E.
ERAM	13-N.	13-E.
E.KONAWA	6-N.	6-E.
E.SHAWNEE	11-N.	5-E.
E.BEEBE	5-N.	5-E.
E.WETUMKA	9-N.	10-E.
FAIRFAX	23-N.	6-E.
FALLS DOME	24-N.	8-E.
FIELDS	11-N.	11-E.
FISH	7-N.	8-E.
FISHER	10-N.	11-E.
FITTS	2-N.	7-E.
FLAT ROCK	20-N.	12-E.
FLESHER	22-N.	9-E.
FORAKER	29-N.	7-E.
FORTY FIVE	26-N.	12-E.
FOX	2-S.	3-W.
FRANCIS	5-N.	7-E.
W. FRANCIS	5-N.	6-E.
FRANKFORT	29-N.	6-E.
FUHRMAN	9-N.	9-E.
FREDERICK DIST.	2-S.	17-W.
	3-S.	19-W.
GARBER	23-N.	3-W.
N.GARBER	23-N.	3-W.
GARR	19-N.	5-E.
GARRETT (Alsan)	27-N.	2-E.
GEORGE	17-N.	15-E.
GESSMAN	14-N.	4-E.
GILCREASE	9-N.	9-E.
GILLETTE	17-N.	17-E.
GILLILAND	23-N.	7-E.
GLENN POOL	17-N.	12-E.
GOBLE	17-N.	15-E.
GOTEBO	7-N.	18-W.
GRAHAM	2-S.	3-W.
GRANITE	7-N.	21-W.
GRAY	6-N.	4-E.
GREENUP	21-N.	7-E.
GREGORY	10-N.	11-E.
GRISSO	6-N.	4-E.
GYPSY HILL	13-N.	11-E.
GRAYSON	6-N.	5-E.
HAZEL DIST.	7-N.	5-E.
HALLETT	20-N.	7-E.
HAMILTON SWITCH	14-N.	12-E.
HANBURY	2-N.	9-W.
HAPPY HOLLOW	24-N.	6-E.
HARDY	25-N.	3-E.
HASKELL	16-N.	15-E.
HEALDTON	4-S.	3-W.
HECTOR	16-N.	13-E.
HENRYETTA	12-N.	12-E.
HEWITT	4-S.	2-W.
HICKORY CR.	28-N.	11-E.
HOGSHOOTER	26-N.	14-E.
HOFFMAN	12-N.	14-E.
N. HOLDENVILLE	8-N.	9-E.
W. HOLDENVILLE	7-N.	8-E.
HOMINY	22-N.	9-E.
E.HOMINY	22-N.	9-E.
HOMINY FALLS	21-N.	11-E.
HUBBARD	26-N.	1-W.
HULL	18-N.	4-W.
HOYT	14-N.	3-E.
HILLSDALE	24-N.	8-W.
INDEPENDENT	16-N.	12-E.
INGALLS	19-N.	4-E.
INOLA	19-N.	16-E.
IRON POST	14-N.	8-E.
ISOM SPRINGS	7-S.	6-E.
JACKSON	3-N.	7-E.
JEFFERSON	6-N.	8-E.
JENKS	18-N.	13-E.
JENNINGS	19-N.	7-E.
JESSE	2-N.	7-E.
JOHNSON-BAILEY	19-N.	16-E.
JOLLY PATTON	14-N.	19-E.
JOSEY	12-N.	11-E.
KASISHKE	24-N.	7-E.
KEATON	12-N.	11-E.
KELLYVILLE	17-N.	10-E.
KEOKUK	11-N.	6-E.
KEYSTONE	19-N.	10-E.
KINGSTON	7-S.	6-E.
KNOX	3-N.	3-W.
KONAWA	6-N.	6-E.
LAMONT	25-N.	3-W.
LAFFOON	13-N.	6-E.
LAMAR	8-N.	12-E.
LANDON	26-N.	9-E.
LANGSTON	17-N.	1-W.
LAUDERDALE	20-N.	8-E.
LAWTON	2-N.	10-W.
LEE DOME	24-N.	6-E.
LENAPAH	27-N.	15-E.
LEONARD	17-N.	14-E.
LINCREEK	15-N.	6-E.
LINK	13-N.	15-E.
LITTLE RIVER	7-N.	6-E.
LITTLE RIVER W.	7-N.	6-E.
E.LITTLE RIVER	8-N.	7-E.
LOCO	3-S.	5-W.
LOVELL	18-N.	4-W.
LUCIEN	20-N.	2-W.
LYONS-QUINN	11-N.	11-E.
MERIDIAN	16-N.	1-E.
MARATHON	22-N.	2-E.
MERCER	16-N.	8-E.
MOORE	10-N.	2-W.
MADALENE	21-N.	10-E.
E.MADALENE	21-N.	10-E.
MADILL	5-S.	5-E.
MANION	23-N.	9-E.
N. MANION	23-N.	8-E.
MANNFORD	19-N.	9-E.
MARAMEC	20-N.	6-E.
MARCH	16-N.	5-E.
MARSHALL	19-N.	4-W.
MASHAM	23-N.	4-E.
MAUD	8-N.	5-E.
MC CRACKEN	16-N.	17-E.
MEEKER (Alsan)	12-N.	3-E.
MEHAN	18-N.	3-E.
MERVINE	27-N.	3-E.
MICAWBER	13-N.	8-E.
MILROY	2-S.	4-W.
MISSION	8-N.	6-E.
MONTEZUMA	12-N.	12-E.
MORGAN	12-N.	11-E.
MORRIS	13-N.	14-E.
MOUNDS	16-N.	12-E.
MUSKOGEE	14-N.	18-E.
N.MUSKOGEE	15-N.	18-E.
MYERS	26-N.	8-E.
N. MARCH	18-N.	5-E.
N.SHAWNEE	11-N.	4-E.
N.WELLSTON	15-N.	2-E.
N.YEAGER	8-N.	10-E.
NATURA	15-N.	13-E.
NAVAL RESERVE	24-N.	7-E.
NELAGONEY	25-N.	10-E.
NEW ENGLAND	25-N.	8-E.
NEWKIRK	28-N.	3-E.
NEWALLA	11-N.	1-E.
NICOMA PARK	12-N.	1-W.
NORFOLK	18-N.	5-E.
W. NORFOLK	18-N.	5-E.
N.BALTIMORE	12-N.	11-E.
NOWATA-CLAGGETT	25-N.	16-E.
NUYAKA	14-N.	11-E.
N.LUCIEN	21-N.	2-W.
N.FITTS	2-N.	7-E.
N.BETHEL	10-N.	7-E.
N.EARLSBORO	11-N.	5-E.
NEWBY	14-N.	9-E.
NOBLE	7-N.	2-W.
N.OCHELATA	25-N.	12-E.
OHIO OSAGE	21-N.	9-E.
OKEMAH	10-N.	9-E.
OKESA	26-N.	11-E.
OKLA. CENTRAL	15-N.	11-E.
OKLA. CITY	11-N.	3-W.
OKMULGEE	13-N.	13-E.
OLEAN	16-N.	8-E.
OLIVE	18-N.	8-E.
OLYMPIC	9-N.	8-E.
ONETA	18-N.	15-E.
OOLOGAH	23-N.	15-E.
ORLANDO	19-N.	1-W.
OSAGE CITY	21-N.	6-E.
E.OSAGE CITY	21-N.	9-E.
OSAGE-HOMINY	23-N.	8-E.
OSCAR	6-S.	5-W.
OTOE CITY	22-N.	1-E.
OWASSO	21-N.	14-E.
OKAY	16-N.	19-E.
OKFUSKEE	13-N.	10-E.
OAK GROVE	19-N.	15-E.
OAKMAN	4-N.	8-E.
OCHELATA	25-N.	12-E.
PAGE	20-N.	11-E.
PALACINE	2-S.	6-W.
PAPOOSE	9-N.	9-E.
PAWHUSKA	25-N.	9-E.
W. PAWHUSKA	25-N.	8-E.
PEARSONIA	27-N.	8-E.
PENN CR.	23-N.	8-E.
PERRY	21-N.	1-W.
PERRYMAN	19-N.	12-E.
PERSHING	25-N.	9-E.
PETTIT	23-N.	8-E.
PHILLIPSVILLE	14-N.	11-E.
PICKETT PRAIRIE	16-N.	11-E.
PINE	14-N.	13-E.
PIONEER	20-N.	11-E.
POLLYANNA	16-N.	11-E.
POLO	22-N.	2-W.
PONCA CITY	25-N.	2-E.
POND CR.	26-N.	10-E.
POOR FARM	18-N.	8-E.
PORTER	16-N.	17-E.
PRUE	21-N.	10-E.
PECK	14-N.	6-E.
PADEN	20-N.	7-E.
QUAPAW	25-N.	11-E.
RAMSEY	18-N.	2-E.
RAINOLA	1-S.	8-W.
RALSTON	23-N.	5-E.
RAMONA	24-N.	12-E.
RED BANK	18-N.	8-E.
REDDEN	1-S.	14-E.
RED FORK	19-N.	12-E.
RED RIVER BED	5-S.	14-W.
RIPLEY	17-N.	4-E.
N.RIPLEY	18-N.	4-E.
ROBBERSON	1-N.	3-W.
ROBINSON	15-N.	18-E.
ROSANNA	8-N.	7-E.
S.CROMWELL	10-N.	8-E.
S.FITTS	2-N.	7-E.
S.NUYAKA	13-N.	11-E.
SPORN	17-N.	3-E.
ST. LOUIS	7-N.	4-E.
SAMS	21-N.	2-W.
SAC-FOX	14-N.	6-E.
SWAN	6-N.	6-E.
SPAULDING	6-N.	6-E.
S.LANGSTON	17-N.	1-W.
SANCHO	8-N.	7-E.
SAND SPRINGS	19-N.	11-E.
SAPULPA	18-N.	11-E.
S.SAPULPA	17-N.	11-E.
SASAKWA	6-N.	8-E.
SASAKWA TNSITE.	6-N.	7-E.
SAYRE	9-N.	23W.
SCHULTER	12-N.	13-E.
SEARIGHT	10-N.	6-E.
N. SEARIGHT	10-N.	6-E.
SEAY	7-S.	5-W.
SELTZER	18-N.	16-E.
SEMINOLE	9-N.	6-E.
E.SEMINOLE	9-N.	7-E.
W. SEMINOLE	9-N.	6-E.
SHAWNEE	10-N.	4-E.
SHELDON	12-N.	11-E.
SHEPPARD	13-N.	15-E.
SCHOLEM ALECHEM	1-S.	3-W.
SIMMONS-BLACK	14-N.	11-E.
SKEDEE	22-N.	6-E.
SKELLYVILLE	15-N.	8-E.
SKIATOOK	22-N.	12-E.
SLICK	15-N.	10-E.
SOMMERVILLE	15-N.	17-E.
S.COFFEYVILLE	29-N.	15-E.
S.ELGIN	29-N.	9-E.
SPENCER	16-N.	14-E.
SPRING	6-S.	6-W.
STEEDMAN	4-N.	8-E.
N.STEEDMAN	4-N.	7-E.
STIDHAM	11-N.	15-E.
STONE BLUFF	16-N.	15-E.
STRIKER	18-N.	16-E.
STROUD	14-N.	6-E.
SUMMERS	11-N.	12-E.
SUNSET	22-N.	9-E.
SEWARD	15-N.	3-W.
STILLWATER	19-N.	3-E.
STOCKTON	6-S.	2-W.
S.WELEETKA	10-N.	11-E.
TALALA	24-N.	16-E.
TATUMS	1-S.	3-W.
TERLTON	20-N.	7-E.
N. TERLTON	20-N.	7-E.
THOMAS	25-N.	2-W.
TIBBENS	13-N.	9-E.
TIDAL-OSAGE	24-N.	8-E.
TIGER FLATS	12-N.	12-E.
TONKAWA	25-N.	1-W.
S.TONKAWA	24-N.	1-W.
TRANSCO	7-N.	7-E.
TRANSCONTAL.	13-N.	16-E.
TULSA	19-N.	13-E.
TURKEY CR.	29-N.	10-E.
W. TURKEY CR.	29-N.	10-E.
TURKEY MT.	18-N.	12-E.
TURLEY	20 N.	12-E.
TUSKEGEE	14-N.	10-E.
E.TUSKEGEE	14-N.	10-E.
TUSSEY	1-S.	3-W.
TIPTON	1-N.	19-W.
TECUMSEH	9-N.	3-E.
TRAUGH	6-N.	6-E.
TYROLA	5-N.	6-E.
VELMA	2-S.	5-W.
VERA	23-N.	14-E.
VERNON	29-N.	1-E.
VINITA	28-N.	20-E.
W.KONAWA	6-N.	5-E.
WAUKOMIS	21-N.	6-W.
W.FITTS	2-N.	6-E.
WAGONER	18-N.	18-E.
S.WAGONER	17-N.	18-E.
WALKER	17-N.	9-E.
WALTERS	1-S.	10-W.
WANN	28-N.	14-E.
WATCHORN	23-N.	3-E.
WEBB	28-N.	3-W.
WEBSTER	19-N.	15-E.
WELEETKA	10-N.	11-E.
WETUMKA	9-N.	10-E.
S.WETUMKA	9-N.	10-E.
WEWOKA	8-N.	8-E.
WEWOKA TNSITE.	8-N.	8-E.
E.WEWOKA	8-N.	8-E.
WHEELER	3-S.	2-W.
WHITETAIL	27-N.	10-E.
WICEY	16-N.	13-E.
WILCOX	15-N.	11-E.
WILCAT JIM	2-S.	2-W.
WILDHORSE	22-N.	10-E.
N. WILDHORSE	22-N.	10-E.
S. WILDHORSE	21-N.	10-E.
WILZETTA	13-N.	5-E.
WOODY	25-N.	14-E.
WOOLAROC	25-N.	11-E.
WOOLSEY	2-S.	6-W.
WRIGHT	18-N.	16-E.
WYNONA	24-N.	9-E.
WOFFORD	6-N.	7-E.
WETLEY	5-N.	5-E.
S.WILZETTA	12-N.	5-E.
W.LOVELL	18-N.	4-W.
YAHOLA	15-N.	16-E.
YALE-QUAY	19-N.	6-E.
YEAGER	8-N.	10-E.
YOUNGSTOWN	14-N.	11-E.

GAS FIELDS

ADA	4-N.	6-E.
BLACKWELL	28-N.	1-W.
CAMERON	8-N.	26-E.
CHICKASHA	5-N.	8-W.
COAL	3-N.	12-E.
CRUCE	1-N.	6-W.
DUSTIN	9-N.	12-E.
EUFAULA	10-N.	16-E.
HOGSHOOTER	24-N.	14-E.
HOFFMAN	12-N.	14-E.
KINTA	8-N.	20-E.
KUSA	11-N.	14-E.
LOCO	3-S.	5-W.
MOORE	10-N.	2-W.

GAS FIELDS

MIDWEST	11-N.	8-E.
N.PONCA CITY	26-N.	2-E.
ONAPA	11-N.	17-E.
POTEAU	7-N.	26-E.
QUINTON	7-N.	18-E.
REDBIRD	17-N.	16-E.
SAYRE	9-N.	23W.
SCHULTER	12-N.	13-E.
S.COLLINSVILLE	21-N.	14-E.
TALALA	23-N.	16-E.
TEXHOMA	1-N.	12-E.I.M.
Y-688	26-N.	10-E.
HUGOTON		
ERICK		



OFFICIAL
NOMENCLATURE
MAPS
KANSAS
OKLAHOMA
TEXAS
WOODS
ALFALFA
GRANT
KAY
NOBLE
WOODWARD
MAJOR
GARFIELD
DEWEY
BLAINE
KINGFISHER
LOGAN
CUSTER
CANADIAN
OKLAHOMA
WASHITA
CADDO
CLEVELAND
KIOWA
GRADY
MC CLAIN
COMANCHE
GARVIN
STEPHENS
MURRAY
TILLMAN
COTTON
CARTER
JEFFERSON
LOVE
WICHITA NATIONAL FOREST
CIMARRON RIVER
RED RIVER
HOBART
CHICKASHA
NORMAN
NEWALLA
JONES
LANGSTON
S. LUCIEN
W. DOYLE
DOYLE
DAVIS
FREDRICK
MILROY
WILMA
NOBLE
28-N. 15-E.I.M.
9-N. 25-W.

FIG. contin

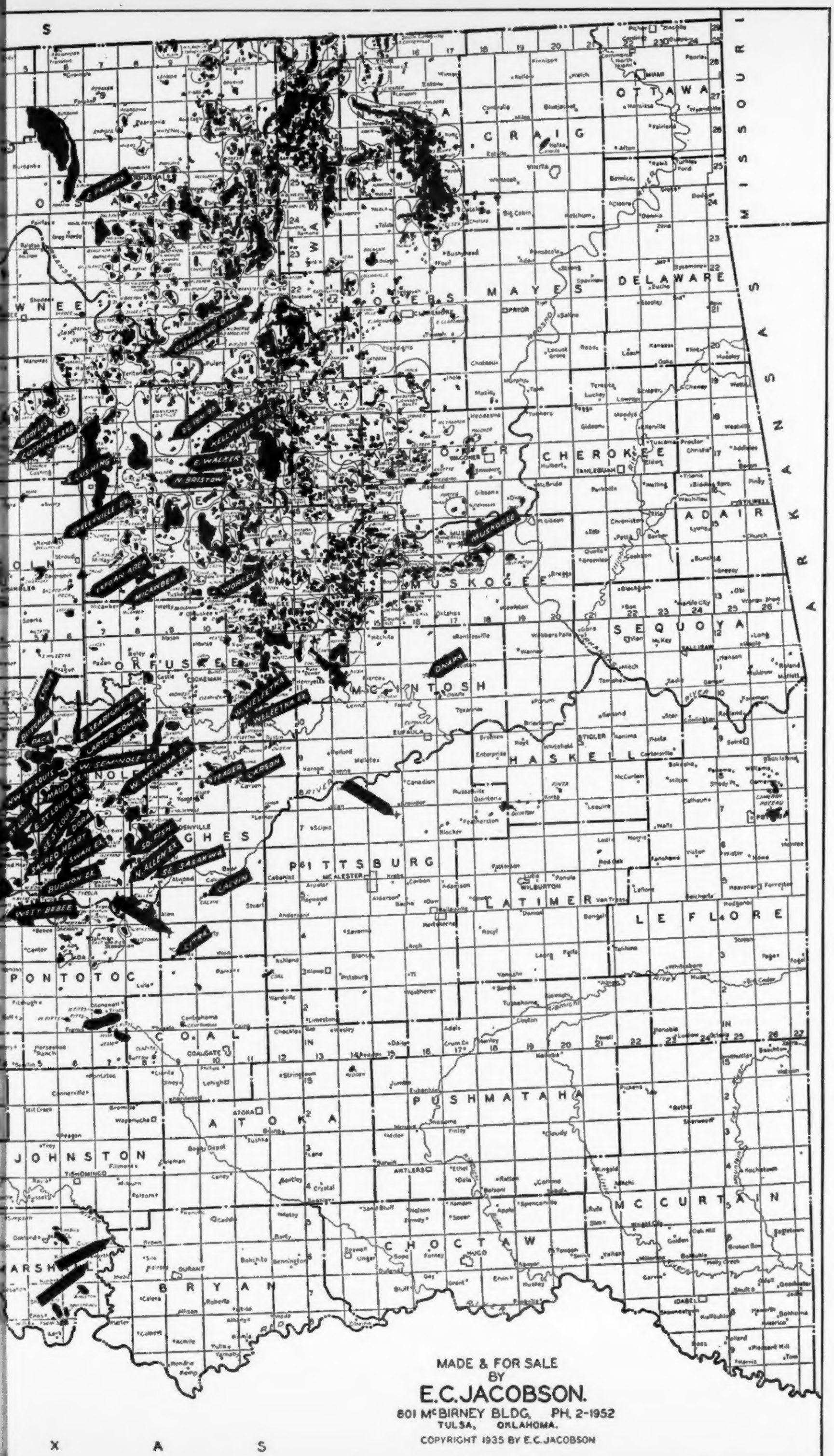


FIG (continued)

important wildcat dry holes and interesting tests still drilling are shown by appropriate symbols on this map.

The new discoveries are distributed in 24 counties—Seminole County with 11 areas and Pottawatomie County with 8, hold the numerical lead. The classification of the wells may be summarized as follows.

	Oil	*Gas*
New pools	23	8
Plug-back operations	4	2
Deeper drilling	6	1
Extensions	16	0

Major companies were responsible for 3 new pools, 4 new zones as a result of plug-back operations, 3 new zones through drilling deeper in old pools, and 1 extension well.

A summary of the comparative exploratory results obtained by major companies and independents is shown in Table V.

TABLE V

COMPARISON OF EXPLORATORY RESULTS OF MAJOR COMPANIES AND INDEPENDENTS IN OKLAHOMA DURING 1939

	Total	*Major Companies*	*Independents*
Total exploratory wells drilled	268	31	237
Total oil wells	49	8	41
New pools	23	3	20
Plug-backs	4	2	2
Deeper drilling	6	2	4
Extensions	16	1	15
Total gas wells	11	3	8
New pools	8	0	8
Plug-backs	2	2	0
Deeper drilling	1	1	0
Extensions	0	0	0
Dry holes	208	20	188

Though the list of new productive areas and new zones seems impressive numerically, the relatively small initial size of most of the discovery wells and the rather unfavorable results of subsequent offset development are disappointing. Many of the areas have already been defined by the completion of one or two producing wells and as many dry holes.

In Table VI is shown the stratigraphic distribution of the Oklahoma new discoveries for 1939.

It may be noted from this summary that the "Wilcox" sand zone which accounted for most of the new reserves during the years 1926–1936 is represented by only 2 minor new pools, 5 deepening operations, and 1 extension.

TABLE VI

STRATIGRAPHIC DISTRIBUTION OF OKLAHOMA DISCOVERIES DURING 1939

	Total Discoveries	Oil				Gas			
		New Pools	Plug-back	Deeper Drilling	Extensions	New Pools	Plug-back	Deeper Drilling	Extension
Pennsylvanian									
Shallow sands	7	2	—	—	1	4	—	—	—
Deese sands	3	1	1	—	—	—	—	1	—
Calvin	4	—	1	—	3	—	—	—	—
Booch	2	2	—	—	—	—	—	—	—
Cleveland	1	1	—	—	—	—	—	—	—
Earlsboro	1	1	—	—	—	—	—	—	—
Layton	1	—	1	—	—	—	—	—	—
Oswego	1	1	—	—	—	—	—	—	—
Prue	5	2	—	—	1	2	—	—	—
Skinner	2	1	—	—	—	1	—	—	—
Bartlesville	1	1	—	—	—	—	—	—	—
Gilcrease	1	—	—	—	1	—	—	—	—
Wapanucka	1	—	—	—	—	1	—	—	—
Cromwell	5	—	—	—	3	—	2	—	—
Siluro-Devonian									
Woodford	1	1	—	—	—	—	—	—	—
Misener	1	1	—	—	—	—	—	—	—
Hunton	9	4	1	—	4	—	—	—	—
Ordovician									
Viola	2	2	—	—	—	—	—	—	—
Simpson Dol.	3	1	—	—	2	—	—	—	—
1st "Wilcox"	3	1	—	2	—	—	—	—	—
2nd "Wilcox"	5	1	—	3	1	—	—	—	—
Arbuckle	1	—	—	1	—	—	—	—	—
	60	23	4	6	16	8	2	1	—

TABLE VII

IMPORTANT DRY HOLES DRILLED IN OKLAHOMA DURING 1939

Operator	Well	Location: County	Location: Sec. T-R	Feet Total Depth	Probable Reason for Drilling	Stratigraphic Penetration	Remarks
Ramsey *et al.*	Mansfield 1	Canadian	16-14N-9W	9,611	Surface structure	186 ft. into Miss. ls.	
Gulf	Hendre	Garfield	21-24N-4W	6,326	Seismograph and core-drill structure	"Wilcox" sd.	
Sinclair-Prairie	George	Harper	5-27N-23W	7,420	Core-drill structure	1,380 ft. into Miss. ls.	
Continental	Hudson	Hughes	8-4N-9E	5,868	Seismograph structure	McLish	
J. E. Trigg	Lankard	Kingfisher	34-17N-6W	8,330	Geophysical structure	Simpson	
Phillips Petr.	Hubacher	Pittsburg	11-7N-15E	7,731	Seismograph structure	Simpson	
Continental	Proctor	Washita	28-10N-20W	14,582	Seismograph structure	Probably still in Penn.	*Deepest* test ever drilled in Mid-Continent

TABLE VIII

IMPORTANT WELLS DRILLING OR COMPLETED IN OKLAHOMA DURING EARLY MONTHS OF 1940

Operator	Well	Location: County	Location: Sec. T-R	Feet Drilling Depth or T.D.	Reason For Drilling	Remarks
Magnolia	Feikes	Dewey	31-18N-14W	9,475	Geophysical	Running pipe. Show gas in drilling mud
Continental	Kretzechmar	Grant	28-28N-5W	5,909	Geophysical	In Tyner section D&A
Anderson Pritchard	Geis	Kingfisher	15-18N-9W	9,356	Geophysical	Had small non-commercial gas and oil in Penn. at 7,330 ft. Drilling in Simpson
McGraw Oil *et al.*	Neff-Godfrey	Marshall	14-6S-6E	4,582	Surface and seismograph	Testing shows in Simpson section, 2,600–4,582 ft. Will drill to Arbuckle
Pure Oil Co.	Q. Little	Marshall	28-5S-7E	5,640	Magnetometer and seismograph	Completed for 5,000 bbls. per day from Bromide-Tulip Creek zone of Simpson
Continental	School Land	Washita	16-8N-16W	6,067	Seismograph	In Pontotoc. Drilling
Sinclair-Prairie	German	Caddo	1-6N-13W	11,026	Seismograph structure	Into Arbuckle, topped at 10,922. Plugging back and testing

INTERESTING NEW DISCOVERIES

Only 3 of the many 1939 discoveries listed appear to be worthy of particular mention. Two of these are new pools and one resulted from deeper drilling operations in a pool already producing.

HOBART POOL, KIOWA COUNTY

Discovery of this pool may be credited to the faith of an independent geologist, Russell S. Tarr, in the significance of surface structural indications and in the authenticity of reported showings in a previously completed dry hole. The first well in the pool, the Gled Oil Company, R. S. Tarr *et al.* Watkins No. 1, was located in the SW. corner of the NW. $\frac{1}{4}$ of Sec. 20, T. 7 N., R. 17 W. The test was drilled with a spudder and was a direct north offset to a dry hole previously drilled several hundred feet into the Simpson zone at a total depth of 1,525 feet. At 1,025 feet in a limestone conglomerate, the Watkins test encountered gas. At 1,049 feet the gas increased and oil appeared. Drilling was discontinued at the total depth of 1,055$\frac{1}{2}$ feet and pipe was set at 1,022 feet. On the basis of an hourly gauge, the production was estimated at 2,000 barrels per day. The oil has a gravity of 35°. There is considerable difference of opinion among geologists as to the age of the producing formation. Some believe that it is a conglomerate of Pontotoc age containing erosional material from older formations, including the Viola and Simpson, while others contend that the material in some of the wells is Viola in place.

There is no pipeline into the field and the oil is marketed by tank cars to small local refiners. The discovery well was completed, May 15, 1939, and by May 1, 1940, there were 8 good producing wells completed and 3 wells drilling in the pool. The structure is not defined and its probable size is still a matter of speculation.

BYARS OR CHISM POOL, McCLAIN COUNTY

The discovery of this pool, like that of the Hobart pool, was due to the faith of an independent geologist, Robert E. Garrett, in the value of a surface structure. In spite of the several dry holes drilled in the immediate area, Garrett continued to acquire leases and royalties on the strength of his interpretation of the surface structure. He was finally able to interest the Patsy Oil Company in the drilling of another test. This well (James No. 1) was located in the NW. corner of the NE. $\frac{1}{4}$, NE. $\frac{1}{4}$ of Sec. 16, T. 5 N., R. 3 E. It had Viola limestone at 3,490–3,623 feet and flowed at the rate of 250 barrels per hour for the first hour. Pinched through a $\frac{1}{2}$-inch choke, it continued to flow 35–50 barrels per hour. The discovery well was com-

pleted in December, 1939. By May 1, 1940, there were 12 producers and several drilling operations in the pool. The pay zone responds favorably to acid and initial productions have been fairly high. Folding in the area is rather steep and subsurface studies indicate that the structure is complicated by one or more faults, which increase the dry-hole hazard and may tend to limit the extent of the pool.

FREDERICK AREA, TILLMAN COUNTY

An interesting development of the year in Oklahoma was the discovery of Arbucke production in the Frederick pool, south of the Wichita Mountains, in Tillman County. The discovery well in the deep zone, the Indian Territory Illuminating Oil Company's Fillmore No. 1, was drilled in the SW. corner of the SE. ¼ of Sec. 36, T. 2 S., R. 19 W., on the north flank of a structure already productive from the Canyon limestone at a depth of approximately 3,100 feet. The Fillmore No. 1 test encountered the base of the Pennsylvanian and the top of Ordovician at a depth of 4,755 feet. At a total depth of 5,135 feet in what is considered to be Arbuckle limestone, the well swabbed as high as 320 barrels per day. The well was completed, May 22, 1939. Deepened in November to a total depth of 5,165 feet, the well produced 1,300 barrels in 24 hours. By May 1, 1940, the three offsets to the discovery well had been completed as producers in the Arbuckle zone. An extension test in the NW. corner of the SW. ¼, NW. ¼ of Sec. 6, T. 3 S., R. 18 W., ½ mile southeast of the discovery, found water in the Arbuckle and was plugged back to the Canyon pay zone.

IMPORTANT DRY HOLES

Only a few of the more important outlying wildcat dry holes completed during 1939 are listed in Table VII.

The outstanding test for the year was the Continental Oil Company's Proctor, in Sec. 28, T. 10 N., R. 20 W., Washita County. It is included with 1939 operations although it is only temporarily abandoned. It is the deepest hole ever drilled in the Mid-Continent fields and within a few hundred feet of the world record. The well penetrated a tremendously thick section of conglomeratic material. From 4,460 to 6,435 feet the formation was typical granite wash. From 6,435 to 12,530 feet the formation consisted of arkosic limestone and arkosic sandy limestone conglomerate with a few thin marine limestones. Below 12,530 feet were black to gray micaceous shales with a few thin sands and limestones. The test required 1 year and 4 months to drill and the cost has been estimated as high as $500,000.

IMPORTANT WILDCATS DRILLING AND COMPLETED DURING EARLY MONTHS OF 1940

There has been no apparent decrease in wildcat activities during the early months of 1940, and a number of new discoveries and extensions have already been recorded.

Table VIII lists only a few of the more interesting test wells which were either drilling or had been completed to May 1, 1940.

Included in the list is perhaps one of the most important new discoveries of the past several years. The Pure Oil Company's Little No. 1 in the center of the W. line of the NE. $\frac{1}{4}$, SE. $\frac{1}{4}$ of Sec. 28, T. 5 S., R. 7 E., Marshall County, has opened what may be a major pool in the Simpson on the south flank of the Arbuckle Mountains. Drilled, according to reports, on the evidence of magnetometer work followed by seismograph work, the well flowed at a rate of 150 barrels per hour through tubing from sand zones in the Bromide and Tulip Creek formations at a depth of 4,857 to 5,100 feet. Before being completed the well was drilled to a total depth of 5,640 feet, into the Oil Creek formation, topped at 5,589 feet. Salt water was found in the basal McLish sand, the well was plugged back to 5,100 feet, casing set at 4,857 feet, and the well produced from the sandy zones between the casing seat and the bottom-hole plug.

The initial capacity of the well indicates the possibility of a pool of considerable size. The immediate wave of concentrated geophysical work and lease and royalty buying along the entire south flank of the Arbuckle Mountains, which followed the Pure discovery has introduced a refreshing change from the routine program of the preceding year.

CONCLUSION

The average total of estimated new reserves, added to Oklahoma's gross reserves by the new discoveries and extensions made during 1939, as compiled from several different sources, is approximately 50 million barrels. With a production during the year of 153,500,000 barrels, the total reserves in the state were reduced by more than 100 million barrels. Though the numerous small pools, minor extensions, and new zones discovered each year tend to retard the decline in Oklahoma's annual production, major additions must apparently await the results of exploratory drilling on more of the outlying geophysical prospects mapped during recent months. The Pure Oil Company's discovery in Marshall County, in what is virtually a new oil province, may encourage other operators to venture farther into the unknown, in search of greater rewards.

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RECENT DEVELOPMENTS IN THE SOUTH MID-CONTINENT[1]

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ABSTRACT

The significant petroleum developments occurring during the year 1939 in Arkansas, Mississippi, Oklahoma, southeastern New Mexico, and all of Texas and Louisiana excepting the Gulf Coast are presented. These developments include the economically important new discoveries and the significant failures as a result of drilling for oil. Brief discussions of wells and dry holes which made important geological data available are also included.

Important new discoveries were encountered in Mississippi, New Mexico, and West Texas. New discoveries, which at the present time do not seem to represent major oil reserves, were recorded in Arkansas, Oklahoma, north and west-central Texas, and East Texas. Northern Louisiana and the Texas Panhandle were without new discoveries or major extensions.

The year 1939 was a period of decreasing reserves in this area since production exceeded additions to reserves represented by new discoveries.

INTRODUCTION

This paper attempts to cover briefly those events of significance to a petroleum geologist which have occurred since the first of 1939 in the south Mid-Continent area—an area including more than a quarter of a million square miles. This area includes the states of Arkansas and Oklahoma, southeastern New Mexico, and all of Mississippi, Louisiana, and Texas, excepting the Gulf Coast.

Before relating the more important developments in each district, it seems in order to make some general statistical statements regarding the whole area.

During 1939, this area contributed 44 per cent of the year's total oil production in this country. Nearly 9,000 of the 27,000-odd wells completed in the United States last year were drilled here. Of these 9,000 wells, 70 per cent were completed as oil producers, 5 per cent as gas wells, and 25 per cent as dry holes. More than 550 of these wells were wildcat tests. This exploratory drilling, which constituted slightly more than 20 per cent of such drilling throughout the country last year, resulted in the discovery of more than 30 per cent of the 260 or so new fields reported for the United States.

MISSISSIPPI

The most spectacular discovery of the year took place when the first commercial oil production in Mississippi became a reality with

[1] Read before the Association at Chicago, April 12, 1940. Revised manuscript received, April 20, 1940.

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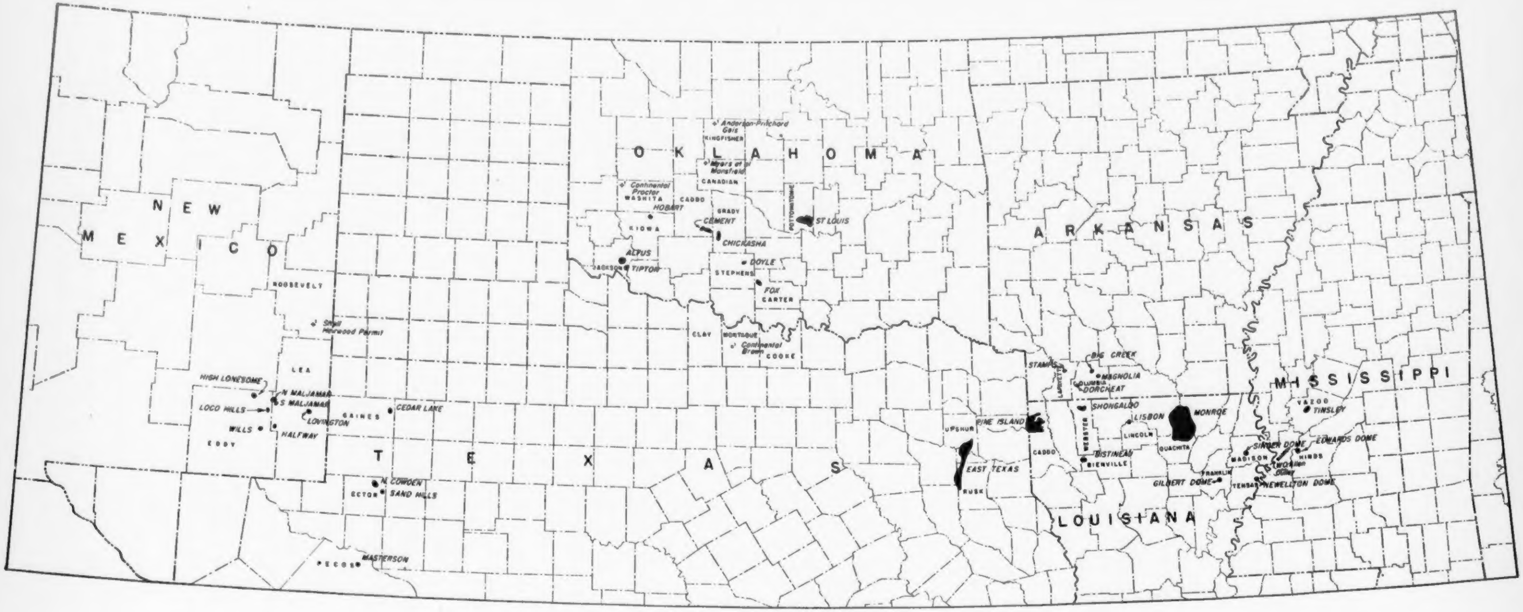

INDEX MAP FOR LOCATING WELLS AND AREAS DISCUSSED IN PAPER

the opening of the Tinsley field in Yazoo County, in the northwestern part of the state. This discovery occurred on September 5, 1939, when the Union Producing Company completed its Woodruff No. 1 at a total depth of 4,560 feet, after topping oil sand at 4,535 feet. This well had an initial daily production of 300 barrels of 34° gravity oil. In November, a second and lower sand was proved productive in the Union Producing Company's Stevens No. 1 when this well was completed in a sand logged between 4,860 and 4,870 feet after having been plugged back from a total depth of 6,111 feet. The two producing beds, named the Woodruff and Stevens sands after the farms on which the discovery wells were drilled, are usually correlated in the Eutaw formation of the Upper Cretaceous, although some geologists hold that the Woodruff sand is Selma in age.

The accumulation of oil, although modified by the pinching-out of the producing sands, is primarily controlled by the structure which is an anticline broken by faulting.

The discovery of this field resulted in a great increase in geophysical activity in Mississippi. At the time of the discovery, there were only three geophysical crews active in the state, but at the end of the year, there were 70 crews, of which half were reflection seismograph units.

ARKANSAS

Of the twelve wildcat tests drilled to the Smackover limestone in Arkansas in 1939, two found production in that formation, thus opening the Big Creek and Dorcheat fields, both of which are located in Columbia County. The former field was discovered when the Standard Oil Company of Louisiana completed its Petty Stave Lumber Company No. 1 on December 23, 1939, as a distillate well at a total depth of 7,999 feet. The top of the Smackover limestone was found at 7,948 feet. The Dorcheat field was opened by the Atlantic Refining Company's Pine Woods Lumber Company No. 1 on September 2, 1939, when the well was completed at a total depth of 9,002 feet. The top of the Smackover limestone was encountered at 8,800 feet.

In addition to these two fields which produce from the Smackover limestone, a third field near Stamps, LaFayette County, was proved productive in the Glen Rose of the Lower Cretaceous, when the East Texas Refining Company completed its Patten No. 1-A on April 19, 1939, at a total depth of 3,606 feet. Later in the year, production was found in the Tokio formation of the Upper Cretaceous.

None of these new fields promises to be of great importance. Actually, the most important development in Arkansas during 1939

was the development of the Magnolia field, Columbia County, into a major producing area after an inauspicious beginning in 1938.

NORTH LOUISIANA

Results from exploratory wells drilled in North Louisiana last year were most disappointing. The immediate commercial results of this drilling are apparent by the score of no new fields, a few minor extensions to old fields, and the finding of new production in sands of the Cotton Valley formation in the Bistineau, Lisbon, and Shongaloo fields.

However, some of these test wells were of considerable significance to the geologists who study this area. Probably the most interesting test was the Dillon Heirs No. 131, deep well of the Stanolind Oil and Gas Company in the Pine Island field, Caddo Parish, which was abandoned at a total depth of 11,419 feet. Top of the salt was logged at 10,159 feet, base of the salt at 11,405 feet, and igneous rock at 11,417 feet. Since the Pine Island uplift is one of the outstanding structures of northwestern Louisiana, with a closure of more than 2,000 feet in the lower Glen Rose, and since more zones have actually produced oil in this field than in any other one field in North Louisiana, the negative results of this deep test naturally have an adverse effect on the future possibilities of deeper production in the whole district.

Another interesting dry hole was the Tensas Delta Land Company No. 1-A of the Union Producing Company in the Monroe gas field, Morehouse Parish. This well recorded salt from 8,114 feet to 9,082 feet and was finally abandoned at 10,475 feet in a black shale, probably pre-Paleozoic in age.

Two new salt domes were found last year in the salt-dome basin of northeastern Louisiana and western Mississippi. Previously the known domes were the Singer dome in Madison Parish, Louisiana, and the Edwards dome in Hinds County, Mississippi.

The Newellton dome in Tensas Parish was discovered in June, 1939, by the Continental Oil Company John Cammack No. 1 which topped salt at 4,123 feet and was abandoned in salt at 4,172 feet.

The Gilbert dome in Franklin Parish was discovered by the same company in September, 1939, when its Sherrouse No. 1 topped salt at 1,778 feet and was abandoned in salt at 1,839 feet.

Another salt dome was found in this basin within the last month when salt was reported at 4,025 feet in the W. O. Allen Culley No. 1 in Warren County, Mississippi.

Lack of oil and gas showings in wells drilled thus far on these salt

domes prevents classification of these structures as good prospects at this time.

OKLAHOMA

Although approximately twenty-five discoveries of new oil and gas producing areas were reported for Oklahoma during 1939, results were disappointing as all these new fields seem to be of minor importance.

The Seminole district was the most active area in the state. This was due not only to the large number of old producers being plugged back to the Pennsylvanian from the Ordovician, but also to the deepening of some of the old producers as well as the drilling of several new tests to lower "Wilcox" sands. This latter development in the "Wilcox" was located principally in the St. Louis field, Pottawatomie County.

In the Ardmore district, some interesting development took place in the Doyle area in Stephens County where at least three sands in the Pennsylvanian were proved productive of oil. The deep development of 1937 and 1938 in the Fox area, Carter County, has been discouraging and some of these deep wells have already been plugged back to shallower Pennsylvanian sands.

On the north side of the Wichita Mountains in Kiowa County, the Hobart field was discovered in August of last year when the Gled Oil Company completed its Watkins No. 1 at a total depth of 1,055 feet. This well, which had an estimated initial daily production of more than 1,000 barrels of 35° gravity oil, produces from the base of the Pontotoc formation. This occurrence is interesting in that the oil has accumulated in what is essentially a stratigraphic trap.

Exploration in the Anadarko basin during 1939 was enlightening but not encouraging. Of the more important tests, the Continental Oil Company's Proctor No. 1 in Washita County attracted the most interest. This well reached a total depth of 14,582 feet, a record depth not only for the state of Oklahoma but also for the entire Mid-Continent. At this depth, the well was still in Pennsylvanian section.

Two other deep wells which failed to reach the Ordovician were drilled on the northeast side of the Anadarko basin. These wells were the Anderson-Prichard Oil Corporation's Geis No. 1 in Kingfisher County and the Myers *et al.* Manfield No. 1 in Canadian County. The former well reached a total depth of 8,507 feet and the latter a total depth of 9,610 feet.

The three wells mentioned and certain other wells have further indicated that the axis of the Anadarko basin is not far from the Wichita Mountains and that along the lower end of this axis, the

Ordovician probably lies below 20,000 feet. The northeast flank of this basin is apparently a relatively smooth and gently dipping slope. The dip of the southwest flank is very steep and because of movements associated with the Wichita Mountains uplift, this flank is sharply folded and faulted.

In the Anadarko basin, the Cement field in Caddo County was the most active because of several extensions as well as the uncovering of several new oil and gas sands, some of which were prolific. The first commercial oil production in the Chickasha field in Grady County was obtained in November when the Alma Oil Company completed its Pettitt No. 5 through perforations in casing from 3,249 feet to 3,264 feet. Initial daily production was estimated at 50 barrels of 26° gravity oil.

South of the Wichita Mountains, the Tipton and Altus fields in Jackson County were active but no important extensions or sands were found.

NEW MEXICO

Drilling activity during 1939 in New Mexico showed an increase over 1938. This increased activity resulted principally from successful explorations along the Artesia-Maljamar uplift which discovered the High Lonesome, Loco Hills, and Wills fields in Eddy County, and the Halfway, North Maljamar, and South Maljamar fields in Lea County.

The Lovington field in northern Lea County which had previously been proved for dry gas in an upper limestone was proved productive of oil in January, 1939, by the Skelly Oil Company. Their State of New Mexico No. 1-N was completed at a total depth of 5,012 feet in Permian limestone as a small producer of 37° gravity oil.

Exploration in eastern New Mexico received a set-back when the Shell Petroleum Corporation's Harwood Permit No. 1 in Roosevelt County was abandoned at 7,957 feet after going directly from lower Permian or upper Pennsylvanian into pre-Cambrian complex.

TEXAS

PANHANDLE

Although no major extensions or new fields were found in the Panhandle of Texas during 1939, drilling continued at a steady rate. Approximately 450 oil wells and 100 gas wells were added to the great Panhandle field last year.

WEST TEXAS

The 1,900-odd wells which were completed in West Texas during 1939 exceeded the number of such completions in any other district

or state in this region under discussion. Although only eight fields were discovered last year in West Texas, several extensions of major importance were found.

Of the new pools, it is likely that the Cedar Lake area in northeastern Gaines County will ultimately be the most important. This field was discovered in September when the Stanolind Oil and Gas Company completed its Rayner No. 1 as a 1,000-barrel well at a depth of 4,770 feet after having plugged back from the total depth of 4,830 feet.

The most interesting discovery of the year occurred in May when the Anderson-Prichard Oil Company *et al.* completed Masterson No. 1 in Pecos County as an oil well producing from the Ellenburger of the Ordovician. Depth of the well is 4,595 feet. Subsequent drilling has proved the pre-Permian structure to have been sharply folded and later deeply eroded, thus exposing an igneous core. Because of these structural complexities, results from drilling have not been consistently successful.

One of the most important strikes in this district last year was the discovery of a deeper Permian limestone "pay" by the Gulf Production Company in its Holt No. 1 in the North Cowden field, Ector County. Since this deep "pay" has been proved for production in both the Sand Hills and North Cowden fields, it is not unlikely that many other fields on the central platform will get this same production.

NORTH AND WEST-CENTRAL TEXAS

As usual, north and west-central Texas contributed many discoveries, about fifty altogether. None of these new fields is important. However, the later development on the east end of the Red River uplift and at the north end of the Fort Worth basin portends greater activity in this area.

In recent months, production has been found in Cooke and Montague counties in beds ranging in age from Strawn to Ellenburger. This activity, coupled with the fact that the Continental Oil Company's Brown No. 1 in Montague County found several hundred feet of normal Ordovician section above the Ellenburger, should intensify the search for oil in this district.

EAST TEXAS

Only two small oil fields and one gas field were found in the East Texas district during 1939. The most important news is that it can now be said that the East Texas field has passed its peak. The number of producing oil wells in this great field has now fallen below 26,000.

CONCLUSION

In conclusion, it is doubtless true that this whole south Mid-Continent area did not contribute any large fields which might threaten the stability of the oil industry.

Discovery of oil in Mississippi encouraged much prospecting but possibilities of finding large reserves are not indicated as yet.

Performance in the North Louisiana district was very disappointing in that not only were there no new fields discovered, but deep drilling such as the test on the large Pine Island structure was not promising for future development of deeper formations.

Arkansas did somewhat better but it is not comforting to know that all possible petroliferous beds in the southern part of the state are within reach of the drill.

Results in East Texas were meager. It is likely, however, that 1939 will be remembered as the year in which the great East Texas field passed its peak in number of producing wells.

Although the present producing districts in Oklahoma do not promise any large increases in oil reserves, the final story on this state can not be predicted at this time because of the Anadarko basin. Recent tests drilled or drilling in this basin indicate that the Ordovician is at such great depths as to delay further prospecting.

In west-central and north Texas, drilling continued as usual with many fields of minor importance being found. However, indications are that the east side of north Texas will receive more extensive exploration during 1940. This should result in fields of better than average quality for the district.

In the Panhandle of Texas, only routine development occurred. This might also be said of New Mexico.

West Texas was by far the most important district in this south Mid-Continent area. Major extensions to old fields, presence of the deeper Permian "pay" in the North Cowden field, and the discovery of more production from the Ordovician made this district an important one.

The year 1939 may begin a period of decreasing reserves. The total oil reserves of this area under discussion increased by a substantial amount last year but this was due entirely to extensions and new pay zones being found. More than 500 million barrels of crude oil were produced from the south Mid-Continent area in 1939. New fields replaced less than one-third of this production.

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DEVELOPMENTS IN WEST TEXAS AND SOUTHEASTERN NEW MEXICO DURING 1939[1]

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ABSTRACT

The West Texas-Southeastern New Mexico district, since the discovery of the Westbrook field in 1921, has marketed approximately 1,250 million barrels of oil, of which more than 100 million barrels were run in 1939. The drilling campaign of 1939 resulted in important extensions to, and linking of, productive fields. In West Texas nine new pools were discovered, two producing from the Ordovician, two from the Pennsylvanian, and five from the Permian. The New Mexico drilling campaign resulted in the discovery of five new pools, all producing from rocks of Permian age.

New discoveries resulted primarily from subsurface geological studies.

The discovery of three new "pays," the geographical location of Cedar Lake, the relatively shallow depth of the new Ordovician pools, and the information gleaned from unproductive wildcats indicate materially greater expectable reserves than hitherto anticipated.

INTRODUCTION

The productive part of the West Texas-Southeastern New Mexico district is shown in Figure 1.

Geologically the district includes a considerably larger area, extending southward and westward to the Rio Grande River. For the regional structural setting, see the index map[3] of the recent West Texas-New Mexico symposium.

The district became an oil-producing area in 1921 with the discovery of the Westbrook field in Mitchell County. From the discovery of Westbrook until 1932, when the first yearly figures were obtainable, it had produced a total of about 600 million barrels of oil. Figure 2 shows graphically the production by years from 1932 to 1940, and the cumulative total to January 1, 1940.

ACKNOWLEDGMENTS

The writers are indebted to so many of the geologists in the area for information, constructive criticism, and statistics, that they feel this paper should appear as a production of the West Texas Geological Society.

Ronald K. DeFord, of the Argo Oil Corporation, has revised the schematic correlation chart (Fig. 3) and prepared and discussed it briefly.

[1] Manuscript received, May 15, 1940.

[2] Geologist, Skelly Oil Company.

[3] Ronald K. DeFord and E. Russell Lloyd, "West Texas-New Mexico Symposium. Part I. Editorial Introduction," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 1 (January, 1940), pp. 2–3, Fig. 1.

WEST TEXAS AREAS

Field	*County*	*Field*	*County*	*Field*	*County*
1. Kyle	Loving	28. Church-Fields	Crane	53. Powell	Crockett
2. Wheat	Loving	29. Dunes	Crane	54. Todd	Crockett
3. Monroe	Ward	30. Crane-Waddell	Crane	55. McDowell	Glasscock
4. Leck	Winkler	31. Jordan	Crane-Ector	56. Roberts	Glasscock
5. Henderson	Winkler	32. Penwell	Ector	57. Settles	Howard
6. Hendricks	Winkler	33. Harper	Ector	58. Chalk	Howard
7. Keystone	Winkler	34. Addis	Ector	59. Snyder	Howard
8. Kermit	Winkler	35. Foster	Ector	60. Moore	Howard
9. Brown-Altman	Winkler	36. Goldsmith	Ector	61. Denman	Howard
10. Halley	Winkler	37. North Cowden-Holt	Ector	62. Dodge-Foster	Mitchell
11. Magnolia-Sealy	Winkler	38. Cummins	Ector	63. Iatan	Mitchell
12. O'Brien	Ward	39. Emma	Andrews	64. Westbrook	Mitchell
13. North Ward	Ward	40. Fuhrman	Andrews	65. Lehn	Pecos
14. Estes	Ward	41. Parker	Andrews	66. Fromme-Crockett	Pecos
15. South Ward	Ward	42. Deep Rock	Andrews	67. Walker	Pecos
16. Sand Hills-Tubbs	Crane	43. Means	Andrews	68. White-Baker	Pecos
17. Netterville	Pecos	44. Kirk	Gaines	69. Waples-Platter	Yoakum
18. Pecos Valley	Pecos	45. Seminole	Gaines	70. Boyd	Cochran
19. Gregg	Pecos	46. Wasson-Denver	Gaines-Yoakum	71. Cedar Lake-Rayner	Gaines
20. Masterson-Apco	Pecos	47. Bennett	Yoakum	72. Scanlon	Dawson
21. Taylor-Link	Pecos	48. Dean	Cochran	73. Sharon-Ridge	Scurry
22. Yates	Pecos	49. Wright	Cochran	74. Ira	Scurry
23. Tobarg	Pecos	50. Slaughter	Hockley	75. Justiceburg	Garza
24. Crockett	Crockett	51. Big Lake	Reagan	76. Post	Garza
25. McCamey	Upton	52. Grayson	Reagan	77. Opp	Schleicher
26. Taylor-Hughes	Crane			78. Cooper-Page	Schleicher
27. Gulf-McElroy	Crane-Upton				

IMPORTANT DEEP TESTS

Well	*County*	*Well*	*County*
1938			
A. Perkins' Cowden 1	Andrews	I. Olsen's Crockett 1	Pecos
B. Ohio's Popham 1	Reeves	J. Anderson-Prichard's Masterson 1	Pecos
C. Magnolia's McKee 1	Pecos	K. Humble's Westheimer 1	Cochran
D. Humble's Robertson 1	Pecos	L. Continental's Todd 2	Crockett
E. Thompson's Elsinore 1	Pecos	M. Gulf's Wristen 5	Ward
F. Gulf's Swenson 1-B	Garza	N Humble's Matador 1	Dickens
		O. Gulf's Swenson 1-C	Crosby
1939		P. Humble's Lewis-Wardlow 1	Tom Green
G. Humble's Young 1	Pecos	Q. Humble's Ozona Barnhart Trap Co. 1	Crockett
H. Magnolia's Abel-Eaton 2	Pecos		

NEW MEXICO AREAS

Field	*County*	*Field*	*County*	*Field*	*County*
1. Artesia	Eddy	11. Lovington	Lea	21. Skaggs	Lea
2. Getty-Barker	Eddy	12. Hobbs	Lea	22. Hardy	Lea
3. Loco Hills	Eddy	13. Monument	Lea	23. Penrose	Lea
4. Shugart	Eddy	14. Eunice	Lea	24. Skelly	Lea
5. High Lonesome	Eddy	15. Wilson	Lea	25. Mattix	Lea
6. Grayburg-Jackson	Eddy	16. South Eunice	Lea	26. Cooper Sand	Lea
7. Maljamar	Lea	17. Lynn	Lea	27. Langlie	Lea
8. Halfway	Lea	18. Cooper	Lea	28. Rhodes	Lea
9. Lynch	Lea	19. Jal	Lea	29. P.C.A.	Eddy
10. Vacuum	Lea	20. Eaves	Lea		

IMPORTANT DEEP TESTS

1938 *Well*	*County*	1939 *Well*	*County*
A. Rowan-Nichols' State 1	Lea	C. Shell's Harwood 1	Roosevelt
B. Tidewater's State 1-L	Lea	D. Turner's State Bank 1	Lea

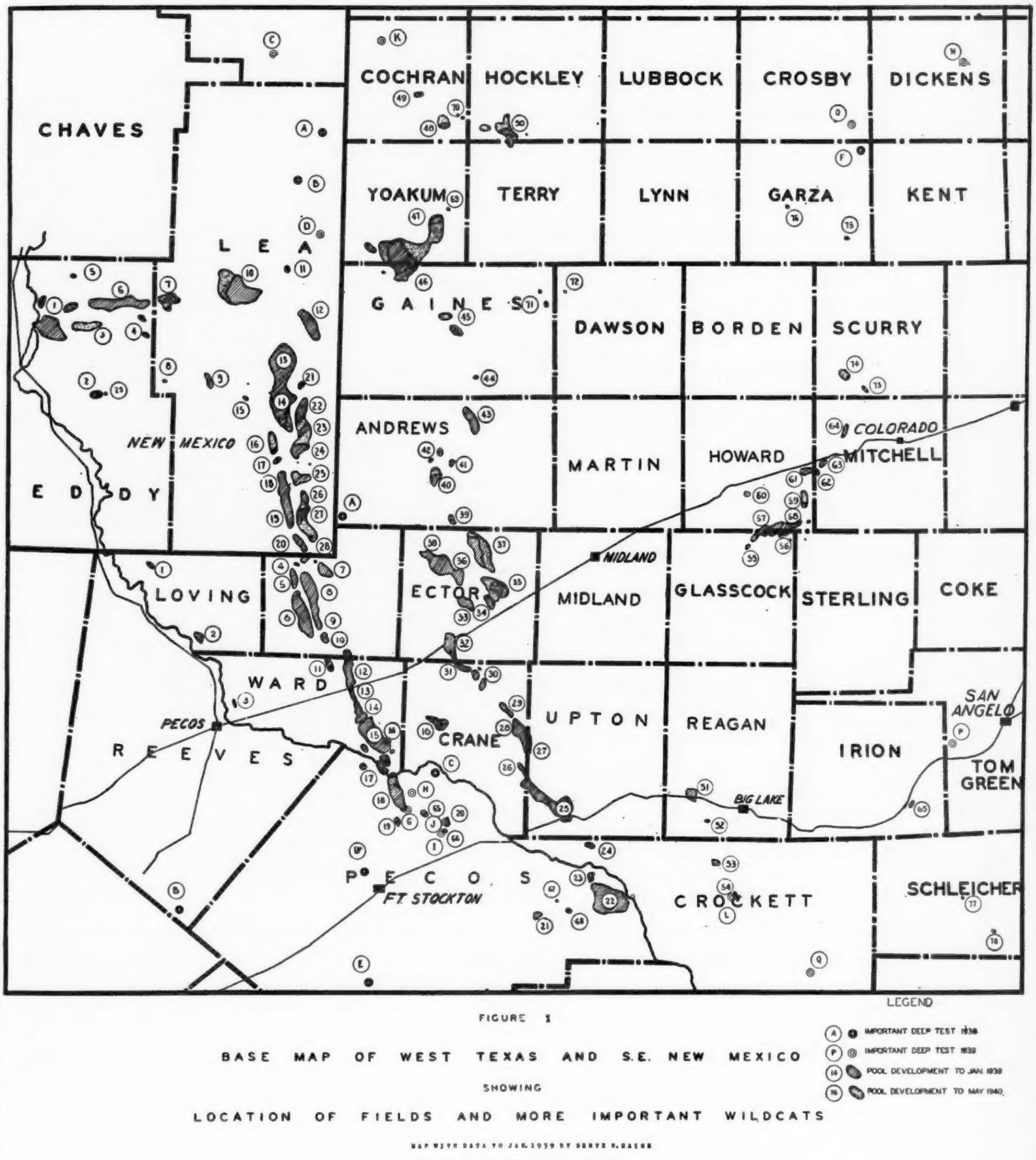

FIG. 1.—Base map of West Texas and Southeastern New Mexico, showing location of fields and more important wildcats.

Berte R. Haigh, of the University Lands, has graciously premitted us to use and revise the base map (Fig. 1) from the last year's paper.[4] To all these "comrades in arms," mentioned and unmentioned, the writers here express their sincere gratitude.

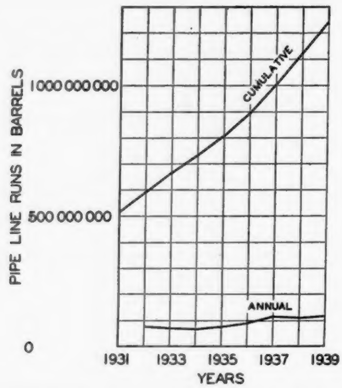

FIG. 2.—Graph showing cumulative total pipeline runs since 1921 and annual runs since 1932.

WEST TEXAS DEVELOPMENTS, 1939

During 1939, there were 1,854 wells completed or abandoned in West Texas, of which 1,635 were completed as oil wells, 5 as gas wells, 137 as dry holes, and 77 were abandoned because of financial or mechanical difficulties before reaching any recognized "pay." Deduction of the 77 abortive attempts yields a success factor of 92.3 per cent for all *bona fide* tests.

Of the 1,854 wells, 132 were wildcats or extension wells and the remaining 1,722 were field wells. As 14 of the 77 prematurely abandoned wells were wildcats, this figure must be deducted from the 132 in computing the success factor for wildcats.

Of the 114 *bona fide* wildcat or extension wells, 29 were productive, giving a success factor of 25 per cent.

The total new potential from the 29 successful wildcat or extension completions was 14,195 barrels per day, or an average of 490 barrels per well.

Most of the successful West Texas wildcats served only to extend, or link, already existing pools. Thus the Bennett pool of Yoakum

[4] H. P. Bybee, Berte R. Haigh, and Surce John Taylor, "Developments in West Texas and Southeastern New Mexico during 1938," *Bull. Amer. Assoc Petrol. Geol.*, Vol. 23, No. 6 (June, 1939).

County and the Denver-Wasson pool of Gaines and Yoakum counties have been joined, during the year, to form the present Wasson pool. Several wildcats were drilled during 1939, between the Duggan pool of Cochran County and the Slaughter pool of Hockley County, which strongly indicate that the two pools will eventually become one large productive area. The North Cowden and Foster pools of Ector County were both extended during 1939. The Tubb "pay" of the Sand Hills pool of Crane County was likewise extended south and east.

The most significant developments from the 1939 crop of wildcats were the discovery of two new Ordovician pools in Pecos County, the discovery of a new productive zone in the North Cowden pool of Ector County, the discovery of Cedar Lake in eastern Gaines County, and the finding, in two widely separated wildcats, of the pre-Cambrian basement.

Early in the year Anderson and Prichard's Masterson No. 1 in Sec. 104, Block 10, H&GN Survey, Pecos County, was completed at a total depth of 4,595 feet in the Ellenburger, flowing an initial production of 184 barrels in 24 hours, naturally. As a result of this discovery, five more wells have been drilled in the area, which is now called the APCO pool. Two of them were too high on structure and missed the Ellenburger, going directly out of Permian into the pre-Cambrian basement. The three remaining wells all found Ellenburger and were completed as oil wells, two of them with initial productions of more than 1,000 barrels per day after acid.

Late in the year Olsen and McCandless brought in their Crockett No. 1, Sec. 5, Block 110, TCRR Survey, Pecos County, producing from the Ellenburger.

The well has a total depth of 4,518 feet and was gauged initially for 531.4 barrels in 5 hours. This well is approximately $1\frac{1}{2}$ miles from the APCO pool and may be proved as an extension of it, or may be a separate Ordovician pool.

It is much too early to predict the outcome of the Ordovician play in West Texas; but the finding of two additional Ordovician pools at the relatively shallow depths of 4,500–4,600 feet indicates that Ordovician exploration and production in this area will not be so expensive and difficult as has been generally assumed.

The Gulf Oil Corporation's Holt No. 1 wildcat just northwest of the North Cowden field, in Sec. 1, Blk. A, PSL Survey, uncovered a new pay section in the Permian. The well was completed at a total depth of 5,200 feet from a fossil coquina which the writers interpret as a shore-line deposit, of lower Guadalupe age, along the east margin of the Central Basin platform. According to this theory the Holt

"pay" has no counterpart on the platform proper; but its distribution may take the form of a peripheral shore-line deposit of the Midland basin. Probably the majority of geologists, however, prefer to consider the Holt "pay" as of lower San Andres, or Clearfork age, and to regard it as equivalent to beds of different facies on the platform proper. The Gulf well was completed, producing 218 barrels of 38.6° API gravity oil. Subsequent tests to this formation have not provided any sensational wells; but there are excellent chances that this "pay" will be of much greater importance somewhere along the margins of the Midland basin.

The 1939 discovery at Cedar Lake in northeastern Gaines County is on a large regional nose, the existence of which has long been predicated by most of the subsurface geologists in the area. Detail seismograph work led the Stanolind Oil and Gas Company to drill the Rayner No. 1 in Sec. 3, Block C-30, PSL Survey, Gaines County. The well was drilled to a total depth of 4,830 feet, then plugged back to 4,770 feet, shot and acidized, and completed, producing 1,279 barrels in 24 hours, on gas lift through one-inch choke. The well is producing from a porous dolomite about 230 feet below the top of the San Andres. Five additional wells have been drilled in the area, all by the Stanolind. All five wells are oil wells though the Stanolind's Riley No. 1, about 3 miles north of the discovery well, is only a small producer. Structurally it is only a few feet lower on the top of the San Andres than the discovery well; but the section equivalent to the "pay" in the discovery well is very anhydritic and only slightly porous. With the present limited amount of exploration, it is impossible to predict properly the future of this pool. However, there are several near-by wells, all of which have reported oil showings and two of which have been small pumpers for some time. Because of the wide distribution of these wells, their relative structural positions, and the presence of the Cedar Lake pool, the entire regional feature must be regarded as a potential oil-producing territory comparable in size and trend with the Westbrook-Chalk trend through Mitchell, Howard, and Glasscock counties.

Besides these developments, which are of more than normal significance because of their implications, the following should be mentioned: the Lehn and Fromme shallow pools of Pecos County, the Cooper-Page and Opp pools of Schleicher County, and a possible new pool, the Waples-Platter, in Yoakum County.

The Lehn and Fromme pools of Pecos County are producing from sands and porous dolomite of the Whitehorse section.

The Cooper-Page pool of Schleicher County, a gas reserve dis-

covered several years ago, became an oil pool during 1939 when the Lone Star Gas Company's Humble-Page No. 1 in Sec. 30, Block L, GH&SA Survey, came in from what appears to be a reef section of probable Strawn age, flowing 158 barrels of 42° gravity oil in 24 hours on $\frac{12}{64}$-inch choke after acid treatment.

The Opp area, also in Schleicher County, resulted from the completion as a 105-barrel per day pumper, after acid, of Opp's Jackson No. 1 in Sec. 44, Block LL, TCRR Survey. The well is believed to be producing from a porous limestone in the Cisco. Gravity of the oil is 34° API.

The Shell Oil Company completed its Waples-Platter No 1 in Sec. 616, Block D, John H. Gibson Survey, Yoakum County, for a pumping initial of 166 barrels of oil plus 56 barrels of salt water after plugging back to 5,305 in an effort to shut off water at the total depth of 5,380 feet. The well is higher structurally than it should be to serve as an extension to the Bennett pool and may be a southwest edge well of a new pool.

There were several deep dry holes drilled during 1939 which are of considerable importance. The Humble Oil and Refining Company's Westheimer No. 1, in northwest Cochran County, was of outstanding importance because it was drilled into igneous or metamorphic rock. While the material in the Humble well is classed as an igneous boulder, it is of such a nature as to create the strong suspicion that the well stopped very close to a pre-Cambrian structural feature, if not actually in it. From neither this well, nor the Shell Oil Company's Harwood No. 1 in Roosevelt County, New Mexico, are any Mississippian or older beds reported above the pre-Cambrian basement, yet both Mississippian and Ellenburger were present in the Gulf Oil Corporation's Swenson No. 1-B in northeast Garza County, and both Simpson and Ellenburger are present in the Crane and Pecos County Ordovician areas, with the exception of the Crockett and APCO pools where only the Ellenburger intervenes between the pre-Cambrian below and the overlying Permian. The Pecos and Crane County productive Ordovician areas are on the southern part of the Permian feature known as the Central Basin platform. The Humble's Westheimer No. 1 and the Shell's Harwood No. 1 are considerably north of the north end of the same Permian feature; but all four areas are west of the axis of the Midland basin, while the Gulf's Swenson No. 1-B is east of that axis. These facts suggest the possibility that the Central Basin platform, as reflected in Permian beds, at least, is the result of an underlying complex of pre-Cambrian structural or topographic features draped with a mantle of Ordovician except over the

highest pre-Cambrian knobs. Therefore, this is a highly likely province for both Simpson and Ellenburger oil, as well as for additional Permian fields similar to the many already found on the platform.

Other important wildcats completed in 1939, or still drilling at the present time, are denoted by the letters *G* to *Q* inclusive in Figure 1.

NEW MEXICO DEVELOPMENTS, 1939

During 1939, 648 wells were completed or abandoned in Southeastern New Mexico, of which 551 were completed as oil wells, 12 as gas wells, 59 as dry holes, and 26 were abandoned because of financial or mechanical difficulties before reaching the anticipated pay. Deduction of the 26 abortive attempts yields a success factor of 97 per cent for all *bona fide* tests. Six of the prematurely abandoned 26 wells were wildcats. Deduction of these 6 from the total of 68 wildcats leaves a total of 62 *bona fide* wildcat attempts, 24 of which were completed as oil wells and four as gas wells yielding a success factor of 45.1 per cent.

The combined new potential from the 24 oil wells was 9,739 barrels daily for an average of 406 barrels per well.

The combined gas potential for the four gas wells was 12,300,000 cubic feet per day for an average of 3,075,000 cubic feet per well.

As in West Texas, most of the wildcat attempts in New Mexico during 1939 turned out to be extensions or connecting wells between already productive areas. However, the Loco Hills pool, the High Lonesome, or Iles pool, the Halfway pool, and the PCA pool, were discovered by 1939 wildcatting and the Lovington pool, which at the end of 1938 consisted of one gas well, was proved for oil.

Loco Hills, which now spreads over approximately 19 square miles in Ts. 17 and 18 S., Rs. 29 and 30 E., was discovered by Yates *et al.* Yates Permit No. 1 which was completed at a total depth of 2,874 feet, from a sand in the lower Whitehorse section, with a flowing gauge of 443 barrels in 24 hours, after shot. As later wells in the pool have found saturation in different sand members, there are several potential "pays" within the section; although very few, if any, wells produce from more than the one "pay." There are now considerably more than 100 wells in the pool, which, for the last few months of 1939 was the most active area in New Mexico.

The High Lonesome or Iles pool resulted from Nolen's Iles Permit well No. 1 which was completed at a total depth of 1,824 feet, in the "Red sand" (uppermost Queen), with a flowing 24-hour initial of 45 barrels after shot. This well is located in Sec. 17, T. 16 S., R. 29 E. Subsequent wells have found sands lower in the Whitehorse section; but as yet there are no large wells in the pool.

COLUMN		1	2	3	4	5
		GLASS MOUNTAINS	DELAWARE BASIN	SIERRA DIABLO GUADALUPE MOUNTAINS HENDRICK FIELD	NEW MEXICO AND MIDLAND BASIN	EAST SIDE OUTCROPS
TERTIARY					Ogallala	Ogallala
CRETACEOUS		Comanche			Comanche	Comanche
TRIASSIC		Bissett	Chinle Santa Rosa Tecovas	Chinle Santa Rosa Tecovas	Chinle Santa Rosa Tecovas	Dockum
PERMIAN	Ochoa	Tessey	Dewey Lake Rustler Salado Castile	Dewey Lake Rustler Salado	Dewey Lake Rustler Salado	
	Guadalupe	Gilliam Capitan Altuda Word	Delaware Mtn.: Bell Canyon Cherry Canyon Brushy Canyon	Capitan Cherry Canyon Brushy Canyon	Carlsbad: Tansill Yates Seven Rivers Queen Grayburg Whitehorse ?	Whitehorse
	Leonard	Leonard (Hess)	Bone Spring	Bone Spring (Victorio Peak is top gray ls. phase)	NEW MEXICO: San Andres (Glorieta is basal ss. phase) Yeso MIDLAND BASIN: San Andres Clear Fork "Wichita"	El Reno: Dog Creek Blaine Flower-pot San Angelo Clear Fork Lueders Clyde Belle Plains
	Wc.	Wolfcamp	Wolfcamp	Hueco	Abo (New Mexico) Wolfcamp (Midland Basin)	Wolfcamp
		MARATHON REGION	EL PASO REGION	CENTRAL BASIN PLATFORM AND MIDLAND BASIN		
PENNSYLVANIAN		Gaptank Haymond Dimple Tesnus	Magdalena	Pennsylvanian		Cisco Canyon Strawn Lampasas Morrow
MISSISSIPPIAN			Helms Lake Valley	Mississippian		Barnett Chappel
DEVONIAN		Caballos	Percha Canutillo	Devonian		
SILURIAN			Fusselman	Silurian		
ORDOVICIAN		Maravillas Woods Hollow Fort Pena Alsate Marathon	Montoya El Paso Bliss	Upper Ordovician Simpson Ellenburger		Ellenburger
CAMBRIAN		Dagger Flat	Van Horn			San Saba Wilberns Cap Mountain Hickory
PRE-CAMBRIAN			Hazel Allamoore Carrizo Mountain	Pre-Cambrian		Packsaddle Valley Spring

FIG. 3.—Schematic correlation chart of West Texas formations.

Another new pool opened by 1939 wildcatting, was the Halfway pool in Sec. 16, T. 20 S., R. 32 E. The discovery well for this area, the Westlea Oil Company's Texas-State No. 1, was completed in October, 1939, at a total depth of 2,629 feet, in a reef dolomite of Capitan age, with a natural swabbing initial of 1,000 barrels in 18 hours. Subsequently, the Argo Oil Corporation completed three additional wells for an average of 195 barrels per well.

Near the end of the year Neil H. Wills' Keys No. 1 in Sec. 15, T. 20 S., R. 30 E., was completed at a total depth of 1,587 feet, in reef dolomite of Capitan age. This well opens a separate pool called PCA, which is some distance east of the Getty and Barber pools. It was completed for a natural pumping initial of 168 barrels of oil in 24 hours.

While the Lovington pool of Lea County is listed as a 1938 discovery, it produced gas only in 1938. Early in 1939, the Skelly Oil Company's State No. 1-N, about 2 miles north of the gas production, was completed from the upper San Andres, at a total depth of 5,012 feet, flowing 121 barrels of oil in 24 hours after acid. During 1939, a gas well and 32 additional oil wells were completed.

One wildcat of paramount importance drilled in New Mexico during 1939 was the Shell Oil Company's Harwood No. 1, which drilled directly from Permian, or possibly Pennsylvanian into a quartzite classed as pre-Cambrian. Because this well is only about 23 miles west of the Humble Oil and Refining Company's Westheimer No. 1, in Cochran County, Texas, its significance has already been pointed out.

BALANCE SHEET OF EXPLORATIONS

In this district it is usually impossible to give the credit for a successful wildcat venture to any single method of exploration. Suffice it to say that the great majority of 1939 wildcat discoveries were located primarily on subsurface geology. In some places, as at Cedar Lake, final location of the discovery well was made as a result of detailed geophysical work; but almost without exception, the regional or local subsurface geology has been the first and paramount influence in the discovery.

To be entirely fair it must be stated that expiring acreage was also a factor in locating wildcat wells; but had the subsurface geology of the area in which these leases were located been unfavorable, most of the leases would have been relinquished without testing.

Geological developments during 1939 included the publication of papers on the Goldsmith field,[5] on the thick saline residues of the

[5] Addison Young, Max David, and E. A. Wahlstrom, "Goldsmith Field, Ector County, Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 23, No. 10 (October, 1939), pp. 1525-52.

Delaware Basin,[6] and the proposed standard Permian section of North America.[7] Progress in correlation has continued. The correlation chart of the recent symposium[8] is brought up to date and included herein as Figure 3. On this chart the San Andres is shown unconditionally as upper Leonard. This correlation is by no means as well established as the chart ind'cates; in fact, the geological controversy as to whether the San Andres is Leonard or Guadalupe is at present one of the sharpest in this district. Some fossils strongly indicate a Leonard age, but some, under present interpretation, are contradictory. The subsurface data, as interpreted by several geologists, indicate a Guadalupe (possibly Cherry Canyon) age. The proper age assignment of Permian beds throughout North America hinges on the correct solution of this problem.

Early in the year it became apparent that the Ellenburger and overlying Simpson must be zoned in order to work out the early geological history of the district. Because of the lithologic changes in the Simpson strata, this is not a difficult task; but the Ellenburger, being of comparatively uniform lithology throughout, presented a different problem. Several of the geologists of the area took it upon themselves to form a coöperative study group with the purpose of making and running insoluble residues of the Ellenburger. As of May 1, 1940, a permanent library of 5,681 residues from 50 strategically located wells has been built up at a cost of $0.037 per sample; with the cost apportioned equally among the fifteen participating companies.

[6] George A. Kroenlein, "Salt, Potash, and Anhydrite in Castile Formation of Southeast New Mexico," *ibid.*, Vol. 23, No. 11 (November, 1939), pp. 1682–93.

[7] John Emery Adams, M. G. Cheney, Ronald K. DeFord, Robert I. Dickey, Carl O. Dunbar, John M. Hills, Robert E. King, E. Russell Lloyd, A. K. Miller, C. E. Needham, "Standard Permian Section of North America," *ibid.*, Vol. 23, No. 11 (November, 1939), pp. 1673–81.

[8] Ronald K. DeFord and E. Russell Lloyd, "West Texas-New Mexico Symposium. Part I. Editorial Introduction," *Bull. Amer. Assoc. Petrol. Geol.*, Vol 24, No. 1 (January, 1940), p. 4, Fig. 2.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 24, NO. 6 (JUNE, 1940), PP. 1044-1061, 1 FIG.

DEVELOPMENTS IN NORTH AND WEST-CENTRAL TEXAS, 1939[1]

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ABSTRACT

Approximately 90 per cent of the production of north and west-central Texas has come from the major positive structural elements: the Bend, Electra and Muenster arches. Increased attention is now being given the bordering basins, especially the north end of the Fort Worth syncline, in which five new fields were found during 1939.

In north Texas shallow reservoirs of Cisco age have contributed by far the greater part of the total production and proved reserves, but shallow production is now declining while deep production, especially from the Strawn, is of ever-increasing importance. Three 1939 discoveries in Archer, Clay, and Montague counties are producing from limestones of Bend age; previously no Bend production had been found north of Young County.

The reflection seismograph has had conspicuous success in the deeper parts of the east half of the north Texas district, but west of the Bend arch it has not yet demonstrated its application except in the discovery of two reef-like masses of Canyon limestone, one of which produces oil in the Seymour field, Baylor County. Surface mapping is no longer an important exploratory tool, but systematic subsurface work is of increasing importance.

Simpson sediments were encountered above the Ellenburger limestone near the axis of the Fort Worth syncline, and increased thickness of post-Ellenburger Ordovician may be looked for farther south in the deeper parts of the syncline.

The top of the Ellenburger was reached in Hardeman County at the greatest depth found to date west of the Muenster arch. The name Hardeman syncline is proposed for the large syncline lying between the Electra arch and the Wichita Mountains.

INTRODUCTION

The north and west-central Texas oil region includes the territory lying between the Central Mineral Region and Oklahoma. Westward it stops short of the producing areas on the east edge of the Permian basin, and eastward is bounded by the Llanoria geosyncline. It is distinctive from its neighboring oil-producing areas in that the bulk of its oil is produced from Pennsylvanian and lowermost Permian beds, whereas the oil of West Texas comes from upper Permian beds, that of East Texas comes from the Cretaceous, and much of that of Oklahoma comes from Paleozoics older than Pennsylvanian.

[1] Read by title before the Association at Chicago, April 12, 1940. Manuscript received, April 18, 1940.

[2] District geologist, Pure Oil Company, 604 Waggoner Building. Data for this paper have been obtained from a series of papers presented for this purpose before the North Texas Geological Society during December, 1939, and January and February, 1940. The papers comprising this series were prepared and presented by Henry Craig, H. C. Fountain, Magnolia Petroleum Company; A. C. Hornady, Phillips Petroleum Company; P. M. Martin, Continental Oil Company; D. J. MacNeil, Shell Oil Company, Inc.; Karl A. Mygdal, Pure Oil Company; L. E. Patterson, Cities Service Oil Company; T. F. Petty and Robert Roth, Humble Oil and Refining Company; J. R. Seitz, Seitz, Comegys, and Seitz, Inc., and Earl M. Stilley. For the valuable assistance given by these authors and by other members of the North Texas Geological Society, the writer wishes to express his deep appreciation.

The area has traditionally been separated into northern and west-central districts whose dividing line is the south line of Young County. The northern half has furnished about two-thirds of the rough total of one billion barrels which has been produced, and is currently much more active in production and drilling than is the west-central area.

The general geology can not be discussed in adequate detail in this paper and the reader is referred to the recent article by Cheney[3] and to the useful index map published in the same *Bulletin*.[4]

It may suffice to say that the chief positive structural elements are the Electra arch, the Muenster arch, and the Bend arch or flexure. At least 90 per cent of the total production of the area to date has come from fields located along the crests of these features, to which are likewise limited the great bulk of the unproduced reserves. No doubt important oil fields will continue to be found along these regional "highs" as deep wildcatting continues, but increased attention is being given to the bordering basins, especially to the Fort Worth syncline. Twenty-two deep wildcats were drilled in this great structural depression during 1939; five new fields were found representing as a group the most important of the new discoveries for the year.

A factor of great importance in the geology of the area is the regional gradational variations of all sediments of Pennsylvanian and Permian age. Apart from considerable local lateral gradation in lithology, which could be expected in these shallow-water deposits, there is a regional decrease in clastics and increase in limestone and evaporites from southeast to northwest away from the source of sediments in the ancient land mass of Llanoria. This change is especially sharp along the axis of the Bend flexure in the north Texas district, where west of this feature the Cisco, Canyon, and Strawn develop numerous thick limestone beds and sands decrease markedly. Such changes have an important bearing on the consideration of possible reservoirs.

In this paper new discoveries, important extensions, and new pay zones are listed in tabular form, grouped by the age of the producing formation. The discussion will be limited to the significant geologic and economic deductions which can be drawn from these discoveries and from the important dry holes.

[3] M. G. Cheney, "Geology of North-Central Texas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 1 (January, 1940), p. 65.

[4] Index Map to regional structure, prepared for mid-year meeting of Amer. Assoc. Petrol. Geol. at El Paso, Texas, September 29 and 30, 1938.

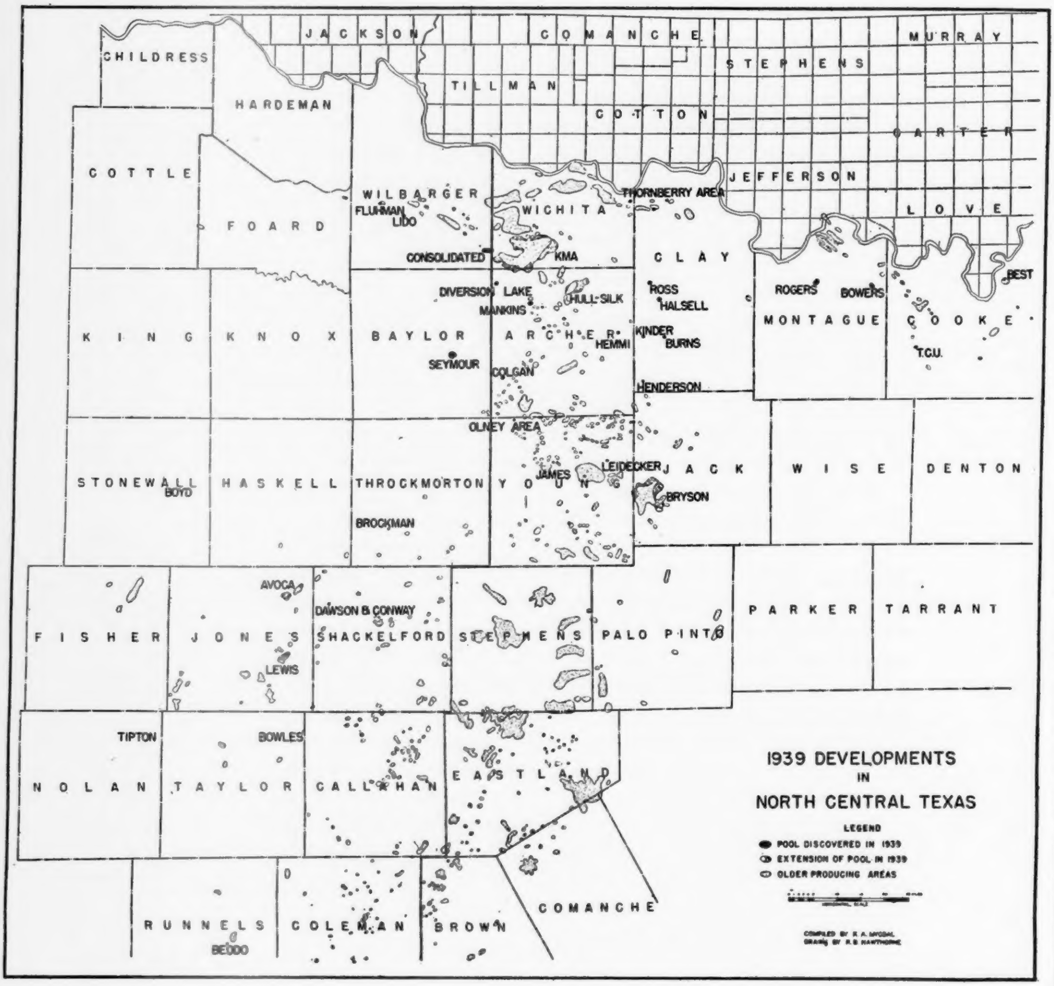
1939 DEVELOPMENTS
IN
NORTH CENTRAL TEXAS
LEGEND
POOL DISCOVERED IN 1939
EXTENSION OF POOL IN 1939
OLDER PRODUCING AREAS
JACKSON
COMANCHE
MURRAY
STEPHENS
TILLMAN
COTTON
CARTER
JEFFERSON
LOVE
CHILDRESS
HARDEMAN
COTTLE
FOARD
WILBARGER
WICHITA
CLAY
MONTAGUE
COOKE
KING
KNOX
BAYLOR
ARCHER
STONEWALL
HASKELL
THROCKMORTON
YOUNG
JACK
WISE
DENTON
FISHER
JONES
SHACKELFORD
STEPHENS
PALO PINTO
PARKER
TARRANT
NOLAN
TAYLOR
CALLAHAN
EASTLAND
RUNNELS
COLEMAN
BROWN
COMANCHE
THORNBERRY AREA
FLUHMAN
LIDO
CONSOLIDATED
KMA
DIVERSION LAKE
MANKINS
HULL-SILK
HEMMI
SEYMOUR
COLGAN
ROSS
HALSELL
KINDER
BURNS
HENDERSON
ROGERS
BOWERS
BEST
T.C.U.
OLNEY AREA
JAMES
LEIDECKER
BRYSON
BOYD
BROCKMAN
AVOCA
DAWSON & CONWAY
LEWIS
TIPTON
BOWLES
BEDDO

FIG. 1

EXPLORATION METHODS

Exploration methods are similar to the general practices throughout the Mid-Continent area.

Discoveries fall into two general classes: shallow Cisco sand "pays" of the Burkburnett and Archer County type, and deep Strawn "pays" of K.M.A. type. The shallow pay zones have contributed the major portion of the north Texas district's total production but their importance has declined greatly and there has not been a major discovery in the class of Electra, Burkburnett, or Nocona for many years. New discoveries at shallow depth, including all those listed in the table accompanying this report, have been small extensions to the major pools or trends, or have been small isolated accumulations. Practically all such discoveries occur in small lenses of sand in which closure is furnished by the pinch-out of the sand into shale updip. Such accumulations are not amenable to prediction by the ordinary geophysical methods or by surface mapping, and the bulk of exploration is done by the drill itself. Such production is generally found between 200 and 1,500 feet, and with the efficient portable rotary rigs and core drills now available holes can be carried to the probable pay zone at small cost. The general philosophy of the shallow operator in the area is that numerous dry holes are inevitable but are justified as part of the finding cost. Naturally, location of such exploratory holes is governed by the usual subsurface information regarding producing leases, dry holes, and oil showings. The value of the geologist in this type of exploration has been in his careful accumulation of accurate structure maps, logs, and sample descriptions; these form a background of facts which allow better planning of drilling programs. One major company has been employing a core drill in Archer County to explore systematically the producing level in that area, and was able to find a new producing field by this method.

The situation is entirely different in the search for deep oil fields of K.M.A. and Hull-Silk type. Such production, chiefly from Strawn beds, now contributes approximately one-third of the total production of north Texas, and in its additions to reserves has been far exceeding shallow discoveries during the past few years. If present trends are continued the day is not far distant when deep production will surpass shallow fields in current production and in oil reserves. Discovery rates and daily production of the shallow fields are declining while those of the deep fields are increasing. For this reason the emphasis of many operators, especially of the larger independents and of the major companies, has shifted to deeper reservoirs.

The search for those reservoirs has extended over the entire district to some extent, but has been concentrated in the north end of the Fort Worth syncline, in Clay, Montague, eastern Archer, and southeastern Wichita counties. The objectives here have been Strawn sands and porous limestones in the Bend group. Such production as has been found has been on anticlinal structures of low relief which are reflected only vaguely in surface or shallow beds. The latter contain few good correlatable beds, and structures are further obscured by regional dip toward the northwest. In this play, therefore, geophysical methods are indispensable. The reflection seismograph has again demonstrated its value and has been used most extensively and with conspicuous success. The entire syncline, north of Jack and Wise counties, has been covered by overlapping seismic surveys, and some work has been done in Jack and Wise counties as well.

In 1938 extensive seismograph surveys were made on the west flank of the Bend arch through Knox, Baylor, Haskell, and Throckmorton counties. This area is essentially a rather featureless monocline with fewer structural irregularities than in the Fort Worth syncline. As a result of this campaign two limestone reefs were located and drilled in 1939, in Haskell and Baylor counties. The one in Baylor was productive in the British-American's Seymour field.

In general, geophysical work has been disappointing on the west flank of the Bend arch, and drilling is governed chiefly by subsurface trend mapping or by random wildcatting. The lesser efficacy of geophysics, as compared to that in the Fort Worth syncline, may be due partly to a larger number of limestones in the section, especially near the surface. Many areas in west-central Texas have good mappable outcrops, but surface closures are extremely rare. If structures are reflected at all on the surface, such reflection is generally only as flattening or gentle nosing of the regional dip. A moderate amount of core drilling has been done. The beds are well adapted to this type of study. During 1939 geophysical activity was very light and limited to a few localities.

As a general statement it may be said that the day of surface mapping in north and west-central Texas has passed. Geophysics, especially the reflection seismograph, has come into its own and is now of prime importance, especially in the northeastern portion. The subsurface geologist, working with drill-cutting sample logs and increasingly with electrical logs, is of basic and increasing importance. Practically all operators now save drill cuttings and rely on subsurface correlations worked out by geologists. It may be mentioned that in sample examination lithologic character is of much greater

importance than fossils. Paleontology does not play a large part in routine correlation, but is of course of great value in wells testing new or unknown sections.

DEVELOPMENTS OF GEOLOGIC SIGNIFICANCE

WICHITA AND ARCHER COUNTIES

Though these counties were the most active in development work, no new information of geologic significance was obtained with the exception that in the deep Mankins pool of north Archer County, the Bend limestone was shown to be commercially productive for the first time north of Young County.

CLAY COUNTY

Four fields were shown productive in the Strawn group and one in the Bend limestones (Table I). The latter is probably similar to the deep Mankins pool in Archer County. Twenty deep wells were drilled, on all of which cuttings were saved and on most of which electrical surveys were made. Largely as a result of 1939 drilling, we are now able to visualize for the first time the character of the sedimentation in this part of the Fort Worth syncline.

Production in the Strawn was obtained from sands 800–1,700 feet below the estimated base of the Canyon group, which places these sands at the general level of the K.M.A. and Hull-Silk sands on the northwest and of the Bryson sands on the south. Exact correlations are difficult. The K.M.A. limestone zone thins and disappears toward the south and east from K.M.A.; the limestones of the Canyon group, which are good markers in Montague County, thin and reduce in number westward and northward through Clay County. The upper limestone of the Canyon, tentatively called "Home Creek" by many geologists in the area, can be traced through the county fairly well, although it is entirely missing in some wells.

The Strawn beds with which exploration is chiefly concerned consist mainly of gray shales with many sands ranging from a few feet to 100 feet in thickness. There are a few thin limestones. These beds were deposited in a rapidly sinking basin during a period which witnessed the greatest orogeny in the Paleozoic history of north Texas. Sediments were derived chiefly from the east and southeast from the ancient land mass of Llanoria. At the beginning of Strawn time the eastern shore line of the Pennsylvanian sea was far to the southeast, and earliest Strawn sediments, found only in the deeper parts of the Fort Worth syncline, consist chiefly of shale. As Strawn orogeny progressed the land mass of Llanoria apparently crowded westward and the Fort Worth syncline was depressed and filled in

front of it. During later Strawn time the eastern shore line of the sea had advanced much closer as is shown by coarse conglomerates in the Strawn beds seen on the surface in Palo Pinto County.

Information given by drilling during 1939 has brought out clearly that in Clay and Montague counties the upper Strawn sediments are distinctly of near-shore type with all the resultant irregularities in sand deposition. Electrical logs show that individual sands can not be traced for more than short distances and that even limestones come and go with considerable irregularity. This factor may be of great economic importance in the future development of the many oil fields which will undoubtedly be found on the west flank of the Fort Worth syncline. As an example, the history of the Burns-Browning field is of interest. The discovery well flowed 312 barrels in 6 hours from 27 feet of sand. In the Shell's Davis No. 1, 660 feet due south, the sand had thinned and tightened so much that the well was a dry hole. The north offset was a small pumping well, possibly not commercial for its depth. The east offset made a satisfactory producer.

The surface beds in Clay County dip north and northwest due to regional tilting. The Bend dips northeast into the Fort Worth syncline. The Strawn beds thicken into the syncline and dips probably grade between those on the surface and those of the Bend. There is no scarcity of sands in any part of the Strawn on the western side of Clay County. In the eastern part of the county, however, the lowest Strawn beds contain little sand and this condition continues into Montague County.

There is no single marker bed which can be traced throughout the county. Satisfactory correlations can be made on a well-to-well basis, however, especially if electrical logs are available to supplement sample information.

MONTAGUE COUNTY

The discovery of commercial production in the Rogers pool greatly accelerated deep drilling and seismograph exploration in the remainder of the county. Most of the work was concentrated in the north half where some structural control from shallow wells was available.

The Rogers field is very probably of anticlinal structure in its lower beds although drilling has not progressed to the point where closure can be demonstrated. Three producing zones are present as indicated in the list of discoveries. While one or more of the zones may be missing in any particular well, no dry holes have been counted among the ten wells completed to the end of the year. The producing sands are fairly regular although some lensing does occur. The field

is on the east flank of the Fort Worth syncline and appears to overlie a peak in the basement rocks, which at this point consist of approximately 200 feet of Bend limestones lying on the Ellenburger. This peak may be on a line of folding parallel and subsidiary to the Muenster arch.

In the Bowers pool the basement rocks were shown to be red granite. The Strawn beds are domed in anticlinal form over a granite peak on the west flank of the Muenster arch. Sand conditions in this pool are especially erratic.

Two deep holes were drilled in the south half of the county. The Continental-Gant's S. J. Brown No. 1, 4 miles north of Bowie, was bottomed at 7,333 feet as the deepest hole ever drilled in the Fort Worth syncline. It topped limestones of the Bend group at 6,077 feet and drilled Mississippian sediments from 6,395 feet to approximately 6,850 feet. From 6,850 feet to the top of the Ellenburger at 7,290 feet Simpson shales and limestones tentatively referred to as the McLish and lower formations were encountered. This is the greatest thickness of post-Ellenburger Ordovician sediments encountered in north Texas to date. Small showings of oil and gas were noted but have not yet been tested. While it appears that the Ordovician encountered is lower in age than the "Wilcox" sand zone of Oklahoma, which if ever present in north Texas has since been removed, the presence of these beds is an important indication. It may be hoped that in the deeper part of the Fort Worth syncline a greater thickness of Ordovician beds will be present among which may be good sand reservoirs.

The Ordovician basement of the Fort Worth syncline is considered to plunge southward. The upper Strawn beds, in contrast, rise toward the south. Thus there is a constantly increasing thickness of new Strawn beds coming into the section toward the south. Three deep wells in southern Montague County, the Continental-Gant's Johnson No. 1, the Staley's Nunnelly No. 1, both drilled in 1939, and the Selby Oil and Gas Company's Batts No. 1 penetrate Strawn beds lower than those found in Clay or northern Montague counties. These three wells show that the uppermost 2,000 feet of the Strawn contain abundant sands similar to those in Clay County. Below this interval, however, a rather marked decrease in sands occurs and the formations consist chiefly of dark gray shales with only occasional thin stringers of sand. Insufficient evidence is at hand as to whether this lack of sands will be general through the deeper Strawn beds in the Fort Worth syncline, but the scarcity of sands in the lower Strawn in southern Montague County must be considered of utmost geologic and economic importance.

The Continental-Gant's Brown No. 1 is located near the axis of the Fort Worth syncline and drilled a total of 3,187 feet of Strawn beds between the base of the Canyon limestone and the top of the Bend limestone zone. That Strawn thicknesses are increasing toward the south is shown by the fact that the Selby well in the southeast corner of the county was still in Strawn 3,640 feet below the base of the Canyon.

COOKE COUNTY

Cooke County has the distinction of furnishing the only commercial Ordovician production in the north Texas district. Production from Simpson limestones and sandy limestone was obtained during the year in the Best pool in the northeast part of the county. A thin remnant of Simpson approximately 200 feet thick overlies the massive Ellenburger dolomite and is overlain by the Strawn, the basal portion of which furnishes the bulk of the field's production. The oil in the Simpson has no doubt migrated into it from the overlying Strawn. In the Voth field, discovered in 1938, development was rapid and the field was drilled completely during 1939. It attained a total area of approximately 200 acres. Many of the wells went to water rapidly and some have already been plugged. The oil here is undoubtedly of Pennsylvanian origin and has migrated into porosity formed in the upper surface of the Ellenburger during its long exposure to erosion in pre-Strawn time.

WILBARGER COUNTY

The King Oil Company's W. T. Waggoner No. 1-U, 3½ miles northwest of the Consolidated field in southeast Wilbarger County, was drilled to the Ellenburger and furnished new information concerning the geologic section in this area. The Electra arch through Wilbarger County is composed of three parallel folds trending from southeast to northwest, named the South Vernon fold, the Rock Crossing fold, and the South fold. Pennsylvanian sediments lie on Ellenburger and pre-Cambrian rocks, which are shallowest on the South Vernon fold and deepest on the South fold. As a result of the varying depths of the basement rocks the lower geologic section varies from fold to fold.

The King well is located on the South fold. It had a complete Cisco section on a full Canyon section which was mostly clastic in character. About 200 feet of Strawn beds were present above the K.M.A. limestone, which was found at 3,812 feet with a slight showing of oil in the top of an oölitic zone. The K.M.A. zone was represented by limestones and sandy shales with no porosity to 4,038 feet and by dense limestone to 4,220 feet. From 4,220 feet to 4,385 feet was a

series of beds having distinctive Bend aspects. From 4,385 to 4,452 feet was mostly shale, green, brown, and black in color, with some conglomeratic sand. This section probably represents Barnett shale of the Mississippian. From 4,452 to 4,485 feet a white to pink and brown crystalline very cherty limestone containing some crinoids was drilled. This limestone was probably the Mississippian Chappell. From 4,485 to 4,535 feet, green shale predominated with some brown limestone and some sandy conglomeratic material suggesting a detrital zone. The age of this zone is indeterminate. It may be Mississippian or it may represent a portion of the Ordovician Simpson.

Ellenburger material was first encountered at 4,535 feet. The dolomite had some porosity and was oil-stained to a depth of 4,595 feet. From 4,595 to 4,600 feet an interesting vein of petroleum residue resembling asphalt or tar was drilled. Below this vein the Ellenburger was hard, gray and densely crystalline to its total depth of 4,622 feet. The well showed approximately 900 feet more geologic section between the Canyon and the Ellenburger than is present on the crest of the Rock Crossing fold.

BAYLOR AND HASKELL COUNTIES

Drilling in 1939 furnished important information regarding the curious bodies of thick massive limestone, assumed to be of reef origin, found in the Canyon group in this part of Texas. Such reefs have produced oil for some years in the Johnson field, Foard County, and in the Wilbarger County fields. In these fields the reefs, all on the order of 1,000 feet thick, are localized on the highest parts of the pre-Pennsylvanian structure and it had been surmised that there was some relation between position high on regional structures and reef development, possibly due to shallow water favoring organic growth. In Baylor and Haskell counties, however, the reefs drilled during the year were on monoclines, not regionally high, and it appears that such reef development can occur regardless of underlying structural conditions.

In Baylor County the British-American is developing its Seymour field which produces from the porous upper surface of a reef of white limestone shown to be 1,310 feet thick in the British-American's Cope No. 1. A few miles away this huge mass of limestone has fingered out into the normal Canyon section of shales, sands and limestones. The reef was located by seismograph shooting.

In Haskell County, the Amerada's Kleiner No. 1, 5 miles east of Haskell, drilled 1,065 feet of solid limestone from 2,869 to 3,934 feet, believed to represent a reef formed practically throughout Canyon

time. Ellenburger limestone was topped at 5,485 feet, subsea 4,020 feet.

The Forest Development's Pardue No. 3, in the Pardue field of southern Haskell County, after failing to produce from the pool's regular 2,850-foot "pay" at the top of the Canyon reef limestone, was deepened in solid limestone, with inconsequential shale breaks, for 985 feet. It was later deepened to 5,510 feet, where it was abandoned in Ellenburger limestone.

These two wells, located 12 miles apart, may be on a single reef; however, it may be inferred from the pattern of Amerada leasing, following seismograph work, that the two wells encountered separate limestone masses. They also furnished the first Ordovician points for Haskell County, which contoured about as was expected. No post-Ellenburger Ordovician was present.

HARDEMAN COUNTY

Deep wells have shown the existence of a large syncline, or geosyncline, lying between the Electra arch and the Wichita Mountains-Amarillo uplift line of folding. This feature is here named the Hardeman syncline. Its outlines are but vaguely known, but drilling during 1939 has helped localize its axis, which appears to be east-west and to lie along a line drawn through the deep Alma Oil Company's Lowe well No. 1 in southeast Childress County and the town of Quanah, in Hardeman County.

The Amerada's Rice well No. 1, drilled 6 miles east of Quanah, is the deepest well ever drilled in north Texas west of the Muenster arch. It reached the Ellenburger at 8,050 feet (subsea 6,574) which is the lowest Ordovician point ever reached in the district west of the Muenster arch. In contrast the highest pre-Pennsylvanian point on the Electra arch is found at subsea 1,032 feet in the Thalia field, 17 miles south of the well. The log of the Amerada well was practically a duplicate of the Alma's Lowe No. 1 in Childress County, with a slightly thicker section. The well showed the axis of the Hardeman syncline, as expressed in the Canyon and lower beds, to lie considerably south of the axis shown by the surface Permian beds.

Only three wells have penetrated the Strawn in the Hardeman syncline. The Amerada well, which is the easternmost, checked the evidence of the other two (Alma Oil Company's Lowe No. 1 in Childress County and Phillips' Hughes No. 1 in Hall County) in that it showed the Strawn to contain practically no sands other than arkoses derived from the uplifts bordering the syncline. Possibly the sands which are so abundant in Clay and Wichita counties were pre-

vented from reaching the Hardeman syncline by the Electra arch, the eastern end of which was probably an island barrier during much of Strawn time.

NOLAN COUNTY

The Plymouth Oil Company's McClure No. 1, 10 miles east and 4½ miles south of the northwest corner of the county, was completed as a dry hole at 7,453 feet, after penetrating 4 feet of Cambrian conglomerate, probably equivalent to the Reagan sandstone. It may be inferred that pre-Cambrian rocks are not far below the completion depth. The Strawn beds had thinned to approximately 75 feet and no Mississippian beds were present. Top of the Ellenburger was at 6,940 feet (subsea 4,544); this depth was normal on the projected contours on the eroded Ordovician surface. The section above the Strawn was normal for the area.

NEW DISCOVERIES

New oil fields, pay zones, and important extensions are listed in Table I grouped by the age of the producing formation. They have been roughly divided into important and unimportant discoveries. These terms are difficult to apply and should be considered in the light of local conditions. Where discoveries indicate the probability of profitable production over a reasonably large area, they have been classed as important; although from the standpoint of large additions to the region's oil reserves no 1939 discovery has yet shown promise of developing into an important field with the possible exception of the Rogers field in Montague County, the Consolidated field in southeast Wilbarger County, and the deep Mankins pool in Archer County.

The discoveries listed can be grouped numerically by formations and by structural features as follows.

Formation		*Structure*	
Cisco	10	Electra arch	6
Canyon	4	Bend arch	18
Strawn	11	Muenster arch	2
Bend	9	Fort Worth syncline	9
Ordovician	1		
	35		35

PRODUCTION AND DRILLING

Drilling was active throughout the year and was increasing at its close. In the total number of wells drilled the north Texas district declined, almost entirely due to a decrease in drilling in the K.M.A. field. There was a moderate increase in the west-central district.

There was no important change in the total production figures for either district. A large percentage of the wells are affected by pro-

TABLE I

NEW DISCOVERIES AND EXTENSIONS DURING 1939

County	Name of Field and Discovery Date	Discovery Well		Initial Production Development	Pay Zone in Feet	Type of Structure	Discovery Method
		Name	Location (Feet)				
CISCO: IMPORTANT DISCOVERIES							
Archer	Colgan 11-6-39	Shell's E. Colgan 1	1,100 from S. & E. line of J. F. Martin Sur.; 4 miles N. of Megargel	Pumped 133 bbls. oil in 24 hrs.; 5 producers, 1 dry hole to end of year	Swastika sand at 1,453–1,463	Sand lens, stratigraphic trap	Core drill
Archer	Diversion Lake (shallow) 6-7-39	E. P. Griffin's W. T. Waggoner Est. 1	466 from E. line, 1,290 from S. line, Sec. 3, H&TC, NW. cor. of county	Pumped 57 bbls. in 24 hrs.; 5 producers, 2 dry holes to end of year	Gunsight sand; 1,629–1,639	Sand lens, stratigraphic trap	Oil show in deeper wildcat
Clay	Thornberry (extension pool in Thornberry field) 11-10-39	E. N. Costley's C. T. Taylor 1-C	337 SE. from intersection of Wichita R. & SW. line of Sec. & 150 from SW. line of Sec. 41, Bacon Subd., 5 mi. SE. of Thornberry; 2 mi. E. of production	Pumped 211 bbls. in 23 hrs.; 4 producers, 3 dry holes drilled	Sand: 1,058–1,074	Sand lens along crest of Electra arch. Total productive area not expected to exceed 200 acres	Random wildcatting along crest of uplift
Wichita	Thornberry (extension of Thornberry field, which lies mainly in Clay County) 11-15-39	Underwood Oil Co.'s W. P. Rogers 1	1,600 from N. line & 2,300 from W. line of farm in Geo. Wheelwright Sur.; 8 mi. NE. of Wichita Falls	Pumped 50 bbls. daily; 6 producers, 1 dry hole to end of year	Sand: 1,200–1,206	Sand lens along crest of Electra arch	Random wildcat
Wilbarger	Fluhman (extension) 8-30-39	Pois, Schultz, and Pigg's J. P. King 1	450 from N. line & 150 from W. line of farm in W. A. McKinney Sur.; $\frac{3}{4}$ mi. W. of Fluhman field	Flowed 388 bbls. in 24 hrs.; 5 producers, 2 dry holes to end of year	Sand: 1,888–1,900. One well completed in sand 1,667–1,684	Local anticline on South Vernon fold	Subsurface mapping
CISCO: UNIMPORTANT DISCOVERIES							
Clay	Thornberry (extension pool in Thornberry field)	W. H. Metzner's Taylor Est. and Metzner 2	Sec. 23, BBB & C Sur., Abst. 67; 1 mile SE. of production	Pumped and flowed 396 bbls. oil in 24 hrs.; 3 producers, 3 dry holes to end of year	Sand: 1,152–1,166	Sand lens along crest of Electra arch	Random wildcat
Runnells	Beddo 9-6-39	Homer-Price *et al.* J. C. Beddo 2	Approx. 1,300 N. of NW. cor. of M. Parrimore Sur. A-26 but in Dominguez Diaz Sur. A-532; 2 miles NE. of Ballinger	Pumped 25 bbls. oil, 120 bbls. salt water in 24 hrs. One additional pumper completed	Sand: 2,346–2,356	Sand lens on local nosing	Not known

County	Name of Field and Discovery Date	Discovery Well: Name	Discovery Well: Location (Feet)	Initial Production Development	Pay Zone in Feet	Type of Structure	Discovery Method
Shackelford	Bluff Creek extension	Fain McGaha Oil Corp.'s Dawson and Conway 1	700 W. of E. line & 535 N. of S. line of the P. G. Holcomb Sur., Abst. 1424	Pumped 131 bbls. in 24 hrs.; 4 oil wells, 1 dry to end of year	Sand: 1,491–1,496	Sand lens on small anticlinal nose	Trend drilling
Taylor	Bowles 2-1-39	F. L. Cooper *et al.* Minnie Bowles 2	600 from S. & 220 from E. line, SW. ¼, Sec 28, B.A.L. Sur.; 5½ miles E. of Abilene	Pumped 9 bbls. oil, 25 water in 24 hrs.; 6 producers, one dry hole to end of year	Sand: 1,748–1,755	Sand lens on local nosing	Random wildcat
Young	Olney district extension pool	E. W. Hunt's H. M. Goss 1	TF & L Co. Sur., Sec. 1592; 6 miles W. of Olney	Pumped 5 bbls. daily; 5 producers to end of year	Sand: 1,219–1,221	Local sand lens. Stratigraphic trap	Random wildcat
CANYON: IMPORTANT DISCOVERIES							
Baylor	Seymour 1-5-39	British American's F. C. Green 1-D	660 from S. & W. lines, SE. ¼, Sec. 215, T & NO Sur., 7½ mi. E. of Seymour	Pumped 165 bbls. oil, 90 bbls. salt water in 24 hrs.; 5 producers, 4 dry holes to end of year	Top of thick reef-like limestone. Porous pay zone: 2,582–2,605	Not known. Accumulation probably controlled by irregularities in elevation and porosity of upper surface of reef	Seismograph
Wilbarger	"Lido pay" (deeper "pay," west end of Rock Crossing field) 9-18-39	Lido Oil Co.'s Waggoner 21-C	990 from N. line, 100 from E. line, Sec. 52, H & TC, Blk. 2	Flowed 99 bbls. 3 hrs.; 2 producers, 1 dry hole to end of year	Limestone at 3,620–3,668; 960 below top of Canyon reef limestone. Age debatable. May be upper Strawn	Local uplift on Rock Crossing anticlinal fold	Deeper drilling in shallow field
CANYON: IMPORTANCE NOT YET DEMONSTRATED							
Nolan	Tipton 9-28-39	Hose and Metcalfe's C. W. Tipton 1	Sec. 43, Blk. 19, T & P, 1,400 from S. line, 942 from W. line, NE. cor. of county	Pumped 31 bbls. oil 8 bbls. water 24 hrs. No additional wells completed	5,137–5,138 OS. 5,145–5,154 OS. First production obtained in Nolan County	Not known	Random wildcat
Stonewall	Boyd	Forest Development's Boyd 1	530 from N. line & 1,930 from E. line, Sec. 45, H & TC, Blk "D"; 6 mi. NE. of Aspermont	Pumped 75 bbls. in 24 hrs. No additional wells	Palo Pinto limestone: 4,690–4,760	Not known	Core drill and surface mapping
STRAWN: IMPORTANT DISCOVERIES							
Clay	Halsell 4-28-39	Bridwell Oil Co.'s Ferd Halsell 1	In Blk. 16, A. Belcher Sur., 3,292 E. & 920 S. of SE. cor. of J. Rogers Sur.	Flowed 159 bbls. in 3 hrs. One additional flowing well completed	Strawn sand: 4,760–4,777	Probably anticlinal. Near axis of Ft. Worth syncline	Seismograph
Cooke	T. C. U. 7-10-39	Wm. O. Russell's Texas Christian University 1	330 out of SE. cor. of W. A. Linn Sur.; 3 mi. S. of Muenster	Pumped 109 bbls. in 24 hrs.; 3 producers, 1 dry hole during year	Sand: 1,125–1,143	Probably anticlinal overlying peak on buried Muenster arch	Random wildcat on subsurface trend

TABLE I—*Continued*

County	Name of Field and Discovery Date	Discovery Well: Name	Discovery Well: Location (Feet)	Initial Production Development	Pay Zone in Feet	Type of Structure	Discovery Method
Montague	Rogers 4,300-foot sand 8-31-39	Youngblood and Foree's Ruth and Kate Davis 1	Appr. 2,000 N. & 1,000 E. of discovery well for Rogers field	Flowed 150 bbls. in 3 hrs.; 4 producers, 2 failures in this sand	Sand: 4,317–4,322; 4,326–4,338	Anticline	Routine development
Montague	Bowers 4-21-39	Benton and Holmes' Joe Bowers 1	450 from E. line & 400 from S. line of Sec. 55, MEP & P Sur. A-528; 3 mi. NE. of Bonita	Pumped 77 bbls., 24 hrs.; 7 producers, 1 dry hole were completed during year	Sand: 2,887–2,926. Later wells have shown sands at 3,400, 3,800, and 3,900. All sands erratic laterally	Anticline over granite knob on west flank of Muenster arch	Random wildcat
Wilbarger	Consolidated 8-7-39	Consolidated Oil Co. and Texas Eastern Oil Corp.'s W. T. Waggoner Estate 1-CC	990 from S. & E. lines of Sec. 36, H & TC, Blk 6	Pumped 250 bbls. oil and 25 bbls. water in 24 hrs.	Limestone: 4,025–4,065; 322 below top of KMA limestone; 12 additional wells flowed from oölitic zone at top of KMA limestone	Anticline	Subsurface mapping on shallow beds, and seismograph
STRAWN: UNIMPORTANT DISCOVERIES							
Archer	Diversion Lake 3-11-39	Deep Oil Development and E. P. Griffin's W. T. Waggoner 1	675 from E. line & 357 from S. line of Sec. 3, H & TC Sur., NW. cor. of county	Flowed 95 bbls. in 3 hrs. Only 1 deep producer completed. Dry holes drilled S. and NW. of discovery	Strawn sand and shale: 4,393–4,410	Not determined	Random wildcat
Clay	Burns 3-11-39	L. T. Burns' A. L. Browning 1	330 from S. & E. lines, Sec. 94, J. H. Belcher Subd.; 5 mi. SW. of Blue Grove	Flowed 312 bbls. in 6 hrs.; 2 flowing wells, 2 small pumpers, 1 dry hole completed in immediate area	Strawn sand: 4,425–4,452. Apparently very lenticular	Probably anticlinal	Seismograph
Clay	Kinder 8-27-39	Frabor-Hodges Corp. and Sinclair-Prairie's R. C. Kinder 1	330 from N. & E. lines, Sec. 11, Blk. 2, Clark and Plumb Sur.; 4 mi. W. of Burns pool	Pumped 157 bbls. in 24 hrs.; 2nd well 1 mile SE. was dry	Strawn sand: 4,130–4,152	Probably anticlinal	Seismograph
Clay	Henderson	Shell Oil Co., Inc.'s H. Henderson 1	990 from N. line & 1,250 from W. line, Sec. 2605, TE & L Sur., SW. cor. of county	Not completed. Good shows on drill-stem tests	Strawn sands: 3,419–3,432; 3,556–3,585	Not known	Seismograph
Young	Not named 2-28-39	Brader and Groves' S. A. Clark 1	C. Newhouse Sur.; 5 mi. W. of Graham	Pumped 40 bbls. daily. No additional wells drilled	Sand and sandy limestone: 3,850–3,865	Not known	Random wildcat
BEND: IMPORTANT DISCOVERIES							
Archer	Mankins Deep 5-29-39	British American's T. B. Wilson 1	330 from N. & W. lines, Sec. 12, H & TC Sur.; 3 mi. S. of Mankins	Flowed 1,816 bbls. in 37 hrs.; 3 additional flowing wells drilled	"Caddo lime" of Smithwick group: 4,666–4,695. 1st commercial Bend production for Archer County	Probably anticlinal	Seismograph

County	Name of Field and Discovery Date	Discovery Well		Initial Production Development	Pay Zone in Feet	Type of Structure	Discovery Method
		Name	Location (Feet)				
Clay	Ross 12-12-39	Continental Oil Co. and Superior Oil Co.'s O. O. Ross 1	1,658 from N. line & 330 from W. line, Wm. Walker Sur.; 4 mi. S. of Jolly	Flowed 142 bbls. in 3 hrs. after acid. No additional wells drilled	"Caddo lime" of Smithwick group: 5,350–5,400	Probably anticlinal	Seismograph
Jack	Birdwell 8-16-39	Nelson Oil Syndicate's O. D. Birdwell 1	466 from S. & W. lines, farm in T. B. Riddle Sur.; 2 mi. W. of Bryson	Flowed 67 bbls. oil in 3 hrs.; 4 producers, no dry holes drilled during year	Sand: 4,380–4,405 within Marble Falls limestone	Not known	Accidental. Edge well in Bryson pool, failure in regular "pay," was drilled deeper
Montague	Rogers 5,200-foot "pay" 12-22-29	Stanolind's Kate Davis 2	467 from S. line & 1,074 from E. line, W. J. Wells Sur.; 2,100 due N. of discovery well for field	Flowed 80 bbls., 1 hr. No additional wells completed during year	Conglomerate zone: 5,228–5,238. Top of Bend limestone: 5,202	Anticline low on W. flank of Muenster arch	Routine development
BEND: UNIMPORTANT DISCOVERIES							
Archer	Hemmi	G. E. Kadane and Son's J. Hemmi 1	466 from N. & E. lines, Sec. 60, Clark and Plumb Subd., Blk. 3	Pumped 60 bbls. in 24 hrs. No additional wells completed	"Caddo lime" of Smithwick group: 5,174–5,284. No additional wells completed	Probably anticlinal	Magnetometer. Subsurface mapping
Throckmorton	Brockman	Jones and Stasney's Brockman 1	330 from S. & E. lines, Sec. 95, Comanche Ind. Res.; 11 mi. SW. of Throckmorton	Pumped 15 bbls. in 24 hrs. No additional wells drilled	"Caddo lime": 4,290–4,337	Not known	Surface mapping
Young	Unknown June, 1939	H. M. Leidecker's J. M. Nall	Sec. 1997, TE & L Sur., ¾ mi. W. of Loving	Flowed 156 bbls. in 3 hrs. after acidizing. Soon declined to 50–60 bbls. daily. No additional wells	"Caddo lime" of Smithwick group: 4,321–4,365	Not known	Not known
Young	James field (deeper sands)	W-E Production Co.'s W. J. Dodd 1	Sec. 647, TE & L Sur.; 8 mi. N. of Graham	Flowed 192 bbls. per day. Several near-by wells deepened to this "pay" without results	Sand in Marble Falls formation: 4,381–4,394	Anticlinal	Deeper drilling
Young	Knight field (deeper sand) July 1939	Rathke Oil Company	B. Hudgins	Flowed 138 bbls. in 6 hrs. Other wells deepened to this "pay" were dry	Sand in Marble Falls formation: 4,217–4,233	Not known	Deeper drilling
Cooke	Walnut Bend (Best)	Sinclair-Prairie's J. M. Best 10	2,310 from N. line & 330 from E. line, T. Toby Sur., NE. cor. of county	Flowed 516 bbls. in 24 hrs.; 5 producers, 2 failures during year	Sand and limestone of Simpson age: 5,496–5,565	Anticlinal	Deeper drilling on productive seismograph structure

ration or by lack of pipeline outlet, and increases in production do not reflect development. The most important change was in an increase of three million barrels in the K.M.A. field, due entirely to enlarged pipeline facilities.

Drilling and production figures are here tabulated.

WELLS COMPLETED IN NORTH-CENTRAL TEXAS

County	*Producers*	*Dry*	*Total 1939*	*Total 1938*
Archer	214	121	335	219
Baylor	6	10	16	8
Childress	0	0	0	2
Clay	72	78	150	172
Cooke	119	40	159	147
Cottle	0	1	1	1
Denton	0	4	4	10
Foard	1	1	2	5
Grayson	1	7	8	5
Hardeman	0	2	2	0
Haskell	0	9	9	11
Jack	68	73	141	254
King	0	0	0	0
Knox	0	0	0	2
Montague	37	16	53	68
Stonewall	2	3	5	7
Throckmorton	6	9	15	16
Wichita	448*	143*	591	1,051
Wilbarger	50	18	68	66
Wise	0	4	4	1
Young	115	130	245	312
	1,139	669	1,808	2,355

* 309 producers and 11 dry holes were drilled in the K.M.A. field, which had 1,246 producers at the end of the year.

WEST-CENTRAL TEXAS

Brown	30	57	87	62
Callahan	14	41	55	42
Coleman	14	21	35	34
Comanche	36	23	59	12
Concho	0	3	3	0
Eastland	8	22	30	21
Coryell	0	0	0	0
Erath	0	1	1	3
Fisher	0	5	5	41
Jones	160	66	226	198
Nolan	1	1	2	0
Hood	0	2	2	1
Johnson	0	1	1	0
Parker	0	1	1	0
Palo Pinto	15	9	24	24
Runnels	1	2	3	0
Shackelford	95	78	173	150
Stephens	10	4	14	12
Tarrant	0	0	0	1
Taylor	9	9	18	14
	393	346	739	615

Oil Production in North-Central Texas District, in Barrels

County	*1938*	*1939*	*Total to Jan. 1, 1940*
Archer	3,854,862	3,927,919	116,612,783
Baylor	417,621	390,765	4,361,888
Clay	543,214	821,528	8,319,147
Cooke	1,741,877	1,959,755	17,160,833
Denton	2,814	2,323	6,000
Foard	207,639	161,010	1,648,322
Haskell	32,606	29,596	160,400
Jack	2,516,004	2,221,465	14,504,484
Montague	1,188,192	1,910,648	30,198,741
Throckmorton	116,029	104,143	3,311,336
Wichita	10,224,872	13,551,677	325,492,222
Wilbarger	3,058,022	3,063,447	68,381,919
Young	4,162,752	3,709,896	64,909,321
Total	28,066,504	31,854,172	655,067,396

Oil Production in West-Central District

Brown	584,460	561,770	29,991,887
Callahan	453,914	408,068	13,980,477
Coleman	353,981	371,485	10,078,922
Comanche	25,352	60,432	
Eastland	1,011,950	948,659	74,696,943
Erath	29,333	23,692	
Fisher	1,252,632	1,056,141	11,395,445
Jones	2,025,503	2,897,770	15,282,570
Nolan	0	1,871	1,871
Palo Pinto	116,478	127,914	5,156,894
Runnels	35,130	24,736	931,892
Shackelford	2,152,611	2,153,290	38,007,155
Stephens	1,266,637	1,231,984	132,856,554
Stonewall	11,394	39,198	50,592
Taylor	26,886	59,652	345,239
Total	9,346,261	9,966,762	332,776,441

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DEVELOPMENTS IN EAST TEXAS DURING 1939[1]

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Tyler, Texas

ABSTRACT

One small oil field and one small oil and gas field were discovered in East Texas during 1939. New gas-producing horizons were found in three old gas fields. Development in proved oil fields was routine in character. Oil-well completions dropped substantially, due to the decline of drilling in the East Texas field. Few important exploratory tests were drilled.

INTRODUCTION

The East Texas district, as herein discussed, includes forty-four counties, or an area of approximately 37,000 square miles (Fig. 1), in the northeast part of the state.

During 1939, there was less drilling activity in this district than at any time since the discovery of the East Texas field. One small oil field[3] and one small oil and gas field were discovered during the year. Gas and distillate production was obtained from new depths in three old gas fields. A total of 720 wells was drilled, classified as follows.

Oil wells	518
Gas and distillate wells	41
Dry holes (fields)	41
Dry holes (exploratory tests)	120
Total	720

Few important exploratory tests were drilled. In most fields, only routine development took place. Several deep tests were drilled in search of new producing beds in proved oil and gas areas, but none of these tests penetrated beds below the Travis Peak.

On January 1, 1940, there were 45 active operations in the district. Thirty-six of these were in proved areas, and nine were exploratory tests.

NEW FIELDS AND PRODUCING AREAS

Mabank (*Henderson County*).—The Mabank area, located $3\frac{1}{2}$ miles northeast of the Flag Lake field in northwest Henderson County, was proved for oil production on April 12, 1939, when Tyler & Smith and Richards & Holloway's Rowe and Baker No. 1 was

[1] Published with permission of the Humble Oil and Refining Company. Manuscript received, May 11, 1940.

[2] Humble Oil and Refining Company.

[3] The Davisville area in northern Angelina County, where two small shallow oil wells were completed, is not included because the wells were not commercial producers.

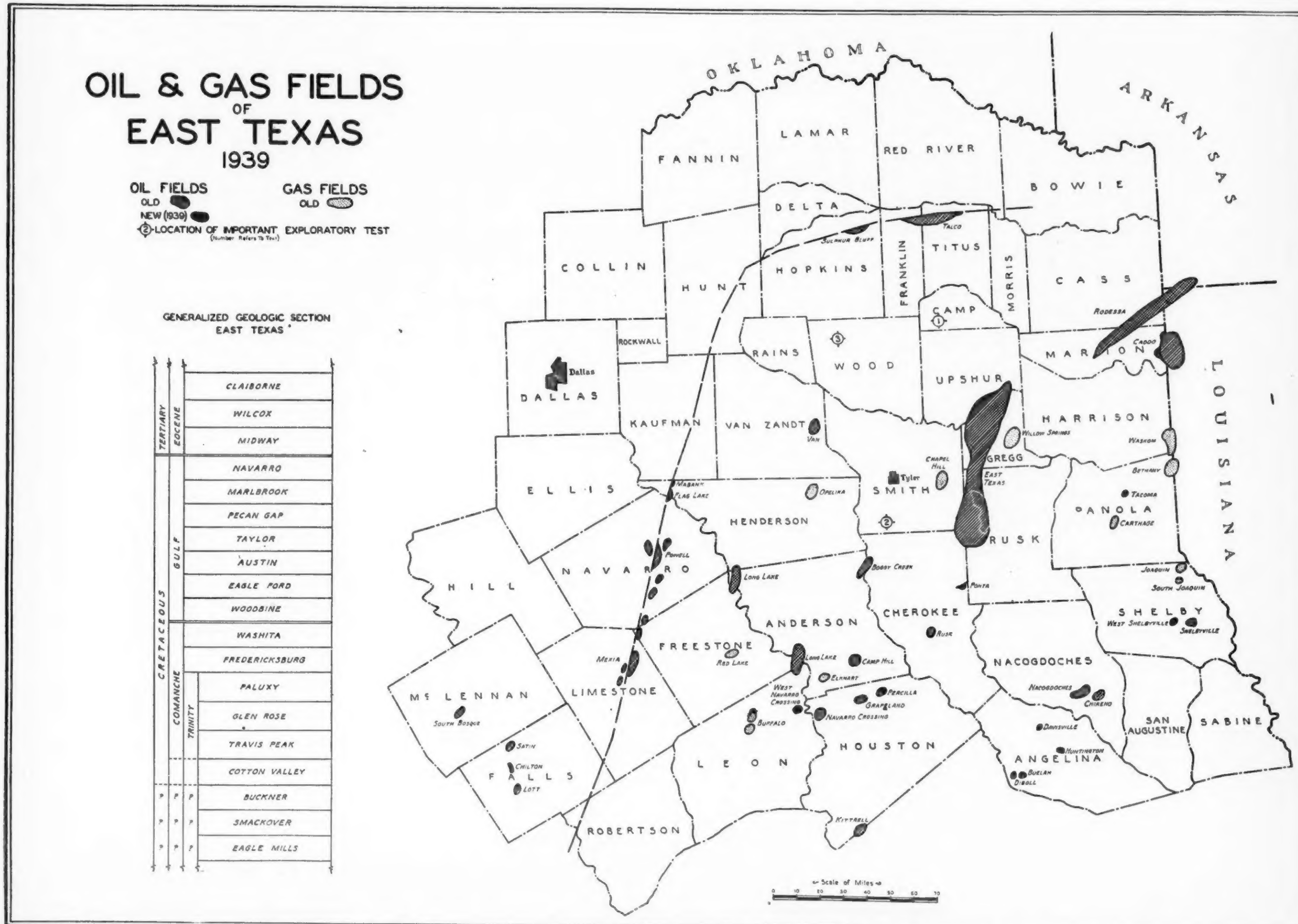
OIL & GAS FIELDS OF EAST TEXAS 1939
OIL FIELDS
OLD
NEW (1939)
GAS FIELDS
OLD
LOCATION OF IMPORTANT EXPLORATORY TEST
GENERALIZED GEOLOGIC SECTION EAST TEXAS
TERTIARY
EOCENE
CLAIBORNE
WILCOX
MIDWAY
CRETACEOUS
GULF
NAVARRO
MARLBROOK
PECAN GAP
TAYLOR
AUSTIN
EAGLE FORD
WOODBINE
COMANCHE
WASHITA
FREDERICKSBURG
TRINITY
PALUXY
GLEN ROSE
TRAVIS PEAK
COTTON VALLEY
BUCKNER
SMACKOVER
EAGLE MILLS
OKLAHOMA
ARKANSAS
LOUISIANA
FANNIN
LAMAR
RED RIVER
BOWIE
DELTA
COLLIN
HUNT
HOPKINS
FRANKLIN
TITUS
MORRIS
CASS
CAMP
RAINS
WOOD
UPSHUR
MARION
ROCKWALL
DALLAS
Dallas
KAUFMAN
VAN ZANDT
HARRISON
GREGG
SMITH
Tyler
ELLIS
HENDERSON
RUSK
PANOLA
HILL
NAVARRO
ANDERSON
CHEROKEE
SHELBY
FREESTONE
NACOGDOCHES
McLENNAN
LIMESTONE
SAN AUGUSTINE
SABINE
HOUSTON
LEON
ANGELINA
FALLS
ROBERTSON
Talco
Sulphur Bluff
Rodessa
Caddo
Van
Willow Springs
Waskom
Bethany
Chapel Hill
East Texas
Tacoma
Carthage
Opelika
Mabank
Flag Lake
Powell
Long Lake
Boggy Creek
Ponta
Joaquin
South Joaquin
West Shelbyville
Shelbyville
Rusk
Mexia
Red Lake
Long Lake
Camp Hill
Elkhart
West Navarro Crossing
Percilla
Grapeland
Navarro Crossing
Nacogdoches
Chireno
Buffalo
Davisville
Huntington
Buelah
Diboll
South Bosque
Satin
Chilton
Lott
Kittrell
Scale of Miles
0 10 20 30 40 50 60 70

FIG. I

completed at a depth of 3,149 feet in the Woodbine formation. The initial production was 86 barrels of 31.7° gravity oil with 85 per cent salt water per day on the pump. One additional oil well and 2 dry holes were completed during the remainder of the year. This field is on an *en échelon* fault in the Mexia-Powell fault zone. Because of dry holes drilled in this vicinity and the thin oil-bearing section, the productive area and ultimate oil production will be very small. The existence of faulting in this area was known as early as 1923 from surface geology.

West Navarro Crossing (*Leon County*).—The West Navarro Crossing oil and gas field is in northeastern Leon County, 3 miles northwest of the Navarro Crossing field in Houston County. The discovery well, the Humble Oil and Refining Company and the Sun Oil Company's E. F. Swift Heirs No. 1, was completed, April 3, 1939, at a depth of 5,906 feet in the Woodbine formation. The initial production was 108 barrels of 35.9° gravity oil per day through 7/32 inch choke, with a gas-oil ratio of 13,780 to 1. During the remainder of the year, 5 more wells were drilled, including 1 high gas-oil ratio well, 2 gas wells and 2 dry holes.

The structure on the Woodbine is a small oval-shaped dome. Since the field has an oil-bearing interval of only 6 feet, the completion of an oil well without an excessive gas-oil ratio is very difficult. The oil production is expected to be small and secondary to the gas production. The presence of structure in this area was first indicated by surface geology, being later confirmed by core drilling and geophysical work.

FIELD DEVELOPMENTS

Buffalo (*Leon County*).—The Lone Star Gas Company completed 1 gas well in the Buffalo field and was testing a second well at the close of the year.

The oil-producing area on the north end of this structure, with one producing well, was further defined by the completion of 2 dry holes.

Caddo (*Marion County, Texas*).—For the first time in many years some activity occurred on the Texas side of the old Caddo field. Nine oil wells and 5 dry holes were completed, which extended the old producing area westward. These wells were completed in the Blossom sand at an average depth of 2,350 feet. Average initial production of these wells was about 20 barrels per day.

Carthage (*Panola County*).—One gas well and one dry hole were completed in the Carthage area, the gas well being the first well in the field to produce from the Rodessa zone. This new producer is

located about 3 miles east of the four older gas wells in this field which are producing from the Pettit zone.

Cayuga (*Anderson, Henderson, and Freestone counties*).—In the Cayuga field, 6 oil wells and 6 gas wells were completed in the Woodbine formation. One well, the Barnsdall Oil Company's Tubbs No. 2, was completed as a gas and distillate producer from the Rodessa zone of the lower Glen Rose. This was the fourth well in the field to produce from this zone. On January 1, 1940, 255 oil wells and 40 gas-distillate wells were producing from the Woodbine. Of the oil wells, 66 were pumping and 189 were flowing.

Chapel Hill (*Smith County*).—The single producing well in the Chapel Hill area, the Hunt Oil Company's Bradley No. 1, continued to produce gas and distillate during 1939. In the latter part of the year drilling began on two wells, the Shell Oil Company's Campbell No. 1 and the Sun Oil Company's Huddle No. 1, located respectively 3 miles north and 2½ miles south of the producing well. The Shell Oil Company's Campbell No. 1 showed gas on a drill-stem test in the Paluxy at a depth of 5,770 feet, but encountered practically no porosity in the Rodessa section, the zone from which the Hunt Oil Company's Bradley No. 1 is producing. On January 1, 1940, the Shell Company well was coring for the Pettit zone at a depth of 8,168 feet, and the Sun Company well was running casing at a depth of 4,407 feet in the Georgetown formation.

East Texas field.—Drilling in the East Texas field dropped substantially in 1939. The number of oil-well completions was 382, as compared with 1,735 in 1938. On September 15, 1939, the method of proration was changed from an hourly potential basis to a method which included factors for potential, bottom-hole pressure, acreage, and sand thickness. A total of 268 oil wells was abandoned during the year, and for the first year in the history of the field the size of the producing area was diminished rather than enlarged. On January 1, 1940, there were 25,960 producing wells, classified as follows.

Flowing	19,016
Gas kick-off	87
Gas lift	720
Pumping	6,068
Dead	69

Of these wells, 4,405 were making 2 per cent or more salt water.

Flag Lake field (*Henderson and Navarro counties*).—Eight oil wells and 6 dry holes were completed at Flag Lake. Five oil wells were abandoned. The only development of interest was the extension of the producing area 3,000 feet southwest into Navarro County. The field had 17 producing wells on January 1, 1940.

Grapeland (*Houston County*).—The Grapeland field experienced considerable activity, including the drilling of 6 gas and distillate wells and 2 dry holes and the building of a recycling plant. On January 1, 1940, 9 gas and distillate wells and 1 oil well were producing in this field.

Joaquin (*Shelby County*).—Developments in the Joaquin field were disappointing. Of the 5 wells drilled during the year, 3 were gas and distillate wells, and 2 were dry holes. One of these wells reached the Pettit, but encountered no showing of oil or gas below the Rodessa section. One well, which had been completed as an oil well in the latter part of 1938, made only a small amount of oil before going entirely to gas and distillate. On January 1, 1940, there were 7 gas wells in the field, of which 4 were closed in and 3 were connected to a recycling plant.

Long Lake (*Anderson, Freestone, and Leon counties*).—Only routine development took place in the Long Lake field. Of the 28 wells completed, 16 were oil wells, 10 were gas and distillate wells and 2 were dry holes. At the end of the year there were 86 oil wells and 51 gas-distillate wells in this field. Of the 86 oil wells, 81 were flowing and 23 were showing some salt water.

Navarro Crossing (*Houston County*).—In the Navarro Crossing field, 18 wells were completed, including 14 oil wells, 2 gas wells, and 2 dry holes. These wells disclosed the presence of several small faults, having average throws of about 40 feet. On January 1, 1940, there were 18 oil wells producing, all of which were flowing. Most of the wells had high gas-oil ratios, and 13 were showing salt water.

Opelika (*Henderson County*).—One gas and distillate well and 2 dry holes were completed at Opelika, all being joint tests of the Tide Water, Seaboard, and Humble companies. These wells showed that this structure has at least 1,000 feet of closure on the lower Glen Rose, that the character of the Rodessa zone is irregular, and that at least the upper 500 feet of the structure contains gas in the Rodessa zone. None of these wells reached the Pettit or Travis Peak formations.

Percilla (*Houston County*).—No activity occurred at Percilla until the latter part of the year, when drilling started on a Trinity test, the Shell Oil Company's Darsey No. 1. On January 1, 1940, this well was fishing at a depth of 9,884 feet in the Rodessa section of the lower Glen Rose. At a depth of 8,576 feet, or about 600 feet below the top of the Glen Rose, a small amount of oil and gas was recovered on a drill-stem test. The source of this showing apparently was a fractured limestone in the upper Glen Rose.

Rodessa (*Cass and Marion counties*).—Thirty-two wells were completed in the Rodessa field, including 27 oil wells and 5 gas wells. All of these wells except one were in Marion County. Of the 503 oil wells producing on January 1, 1940, 191 were on the pump and 207 were showing salt water.

South Groesbeck (*Limestone County*).—On November 26, 1939, the Samuels *et al.* Barron No. 1, located 4 miles southwest of Groesbeck in a shallow gas-producing area, was completed at a depth of 6,041 feet (plugged back to 5,744 feet), with an initial production of 5,570,000 cubic feet of gas per day through $2\frac{1}{2}$-inch tubing. Distillate content was estimated to range from 5 to 8 barrels per million cubic feet of gas. The gas is being produced from the Pettit zone of the lower Glen Rose. This well is located on a fault with a throw of about 270 feet on the Woodbine.

This is the first well in the Mexia fault trend to find gas in commercial quantities below the Woodbine.[4]

Talco (*Titus and Franklin counties*).—Forty-three oil wells and 1 dry hole were completed in the Talco field during the year. Forty oil wells, located mainly in the Talco townsite, were abandoned. The only development of interest was the extension of the field more than a mile east, thereby adding about 450 acres to the productive area. Of the 689 wells producing in this field on January 1, 1940, all were on the pump, and 505 were showing salt water.

Waskom (*Harrison County*).—In 1939, the Arkansas-Louisiana Gas Company completed 4 wells in the Waskom field, including one well in Louisiana, producing gas and distillate from the Pettit and upper Travis Peak zones, at depths of approximately 6,000 feet. The average distillate content of the gas was about 15 barrels per million cubic feet. Most of these wells showed gas in the Rodessa zone. These were the first wells in this field to produce from the Pettit and the Travis Peak. One other well, the Arkansas-Louisiana Gas Company's Abney No. 1, completed in 1938, is producing gas from the Rodessa zone.

IMPORTANT EXPLORATORY TESTS

Camp County.—Moss *et al.* Venters No. 1 (*1*)[5] in western Camp County was drilling at a depth of 6,515 feet in the Glen Rose formation on January 1, 1940. This well was drilled originally as a Paluxy test

[4] Peyton Brothers' Steubenrauch No. 1 in the Mexia field was completed in 1938 as a small gas well in the Pettit zone, but never has produced gas in commercial quantities.

[5] Italic numerals in parentheses refer to numbers in Figure 1, indicating locations of important exploratory tests.

by W. C. McGlothlin *et al.* and was abandoned, June 26, 1938, at a depth of 5,710 feet. It encountered no showing of oil in the Woodbine or Paluxy, but indicated the presence of structure. Moss *et al.* took over this well and in December, 1939, began operations for deepening it to the lower Glen Rose. The presence of structure in this area was first noted from surface geology and later confirmed by core drill and seismograph work.

Smith County.—The Texas Company's Scritchfield No. 1 (*2*), located near Bullard in southwestern Smith County, was abandoned, November 2, 1939, at a depth of 8,100 feet, in the Glen Rose formation. No showing of oil or gas was found in the Woodbine or Paluxy. The presence of structure in this area was first indicated by surface geology and later checked by reflection-seismograph work.

Wood County.—Strake *et al.* Farrier No. 1 (*3*), located near Yantis in northwest Wood County, was abandoned, April 11, 1939, at a depth of 6,507 feet in the upper Glen Rose. This well, which was drilled on a seismograph prospect, found a showing of dead oil in the Eagle Ford but encountered no showings in either the Woodbine or Paluxy.

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DEVELOPMENTS AND STATUS OF OIL RESERVES IN SOUTH TEXAS, 1939[1]

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ABSTRACT

South Texas has three natural subdivisions, pre-Eocene producing area, Eocene producing area, and post-Eocene producing area.

During 1939 thirty new pools were added. Major discoveries resulted from deeper drilling on producing structures.

Geological work was less than in previous years; however, several practices of value to geological work were either inaugurated or enhanced in their general use.

Pressure maintenance plants for extracting optimum condensate recovery in gas fields reached an important stage of development.

Oil reserves amount to 1,260 million barrels or the equivalent of 15.5 years supply. Reserves and production have increased 300 per cent and 400 per cent, respectively, since 1933.

INTRODUCTION

The South Texas petroleum area is bounded on the north, west, south, and southeast by the Llano-Burnet uplift, Rio Grande River, and Gulf of Mexico. The accepted eastern boundary includes Jackson County and extends north and east to comprise Milam and Williamson counties.

In previous annual résumés of development, South Texas has been divided into three districts, namely: San Antonio, Laredo, and Corpus Christi. These delineations are modified whereby the San Antonio district includes all pre-Eocene production, the Laredo district (including Beeville area) all Eocene production, and the Corpus Christi district all post-Eocene production. Distinctions, other than their geographical extents and the separate geological ages of their producing horizons, are: these three provinces have distinct types of crudes and in most instances distinct types of accumulation.

The year 1939 added few new reserves and at the beginning of 1940 most major pools were either defined or close-in developments had limited their areal extents. It is not anticipated that development will add appreciable reserves to the present producing zones in pools discovered prior to 1940.

Geophysical and exploratory geological work took place as isolated efforts rather than on the general programs of the recent previous years. Major companies offered few inducements to wildcatting.

[1] Read before the Association at Chicago, April 12, 1940. Manuscript received, March 6, 1940.

[2] Geologist, 636 Nixon Building. The writer is indebted to many South Texas geologists for their coöperation in providing data and their criticisms. Had they not contributed valuable information on past production and developments it would have been impossible to acquire the included estimates of reserves.


OIL & GAS FIELDS
SOUTH TEXAS
SCALE IN MILES
By
L.B. HERRING
CORPUS CHRISTI, TEX.
LEGEND
Pools discovered prior to 1939
New pools discovered in 1939
REPUBLIC DE MEXICO
Gulf of Mexico
Rio Grande
DRAWN BY
PORTER REGENOLD
CORPUS CHRISTI, TEX.

FIG. 1

Wildcatting diminished approximately 25 per cent from the previous years and the quality of most prospects which were tested was below that of the last few years. Total drilling operations dropped very little from the previous year.

DISCOVERIES IN 1939

No major discovery is known to have been made in the thirty new producing areas added in 1939. Data on these pools are listed in Table I. Fifteen of the discoveries were gas wells and fifteen made oil wells. Five of the discovery oil wells opened pumping pools and one has been temporarily abandoned. The largest oil and condensate reserves found in new areas were Ben Bolt, La Gloria, and Reynolds, Jim Wells County, and Melon Creek, Refugio County. An important discovery of the year occurred at West Ranch, Jackson County. Production in the *Heterostegina* zone had been found previously but the Frio production in this pool should be attributed to 1939.

TABLE I

Field Name	*County*	*Sand Depth in Feet in Producing Well*	*Producing Formation*	*District*	*Initial Production*	*Choke (Inches)*
Adami	Webb	992– 999	Jackson	Laredo	70 b.p.d.,* 20 gr.†	Pump
Ben Bolt	Jim Wells	5,231– 51	Frio	Corpus Christi	144 b.p.d., 42.5 gr.	1/8
Blucher	Jim Wells	7,500– 59	Frio	Corpus Christi	14,000 m.c.f.‖	1/8
Camada	Jim Wells	5,630– 35	Hockleyensis	Laredo	40 b.p.d., 46.5 gr.	5/64
Chiltipin	Duval	4,760– 90	Cockfield	Laredo	Gas well	1/8
Cologne	Victoria	2,860	Catahoula	Corpus Christi	4,000 m.c.f.	3/8
Elm Creek	Guadalupe	704– 28	Navarro	San Antonio	15 b.p.d., 40 gr.	Pump
Fannin	Goliad	2,840– 70	Frio	Corpus Christi	15,500 m.c.f.	
Heard	Bee	4,766– 76	Frio	Corpus Christi	4,000 m.c.f.	3/16
North Keeran	Victoria	5,550– 52	Frio	Corpus Christi	Gas well	
North Luby	Nueces	4,347– 63	Catahoula	Corpus Christi	173 b.p.d., 56 gr.	1/8
Magnolia City	Jim Wells	5,440– 50	Frio	Corpus Christi	108 b.p.d., 42.8 gr.	1/8
East Mathis	San Patricio	5,265– 75	Frio	Corpus Christi	40 b.p.d., 35.5 gr.	1/8
Melon Creek	Refugio	5,854– 77	Frio	Corpus Christi	380 b.p.d., 37.5 gr.	3/32
Minnie Bock	Nueces	3,797–3,802	Catahoula	Corpus Christi	122 b.p.d., 23.6 gr.	5/32
Mountain View	Live Oak	2,476– 81	Hockleyensis	Laredo	Small gasser	
Muralla	Duval	4,712– 15	Cockfield	Laredo	30 b.p.d., 42.6 gr.	7/64
Odem	San Patricio	6,980–7,003	Frio	Corpus Christi	5,500 m.c.f.	1/4
Powder Horn	Calhoun	4,628– 35	Catahoula	Corpus Christi	700 m.c.f.	1/8
Red Rock	Bastrop	2,305– 48	Austin	San Antonio	60 b.p.d., 36.2 gr.	Pump
Reynolds	Jim Wells	5,128– 60	Frio	Corpus Christi	60 b.p.d., 37 gr.	5/8
Robstown	Nueces	5,548– 66	Frio	Corpus Christi	3 b.p.h.,** high gas-oil ratio	3/16
Sejita	Duval	5,335– 50	Hockleyensis	Laredo	1,712 m.c.f.	3/16
Southland	Duval	5,286– 98	Cockfield and Hockleyensis			
			Hockleyensis	Laredo	220 b.p.d., 42.7 gr.	5/32
Tarancahuas	Duval	2,015– 35	Frio	Laredo	300 b.p.d., 21 gr.	3/8
Texana	Jackson	5,690–5,770		Corpus Christi	Gas well	
Victoria	Victoria	2,543– 58	Catahoula	Corpus Christi	500 m.c.f.	9/64
Volpe	Webb	2,458– 66	Jackson	Laredo	50 bbls. in 12 hrs.	Pump
Wade City	Jim Wells	4,748–4,810	Frio	Corpus Christi	2,000 m.c.f.	1/8
White Creek	Live Oak	1,390– 97	Hockleyensis	Laredo	33 bbls. in 14 hrs.	Pump

* Barrels per day (oil).
† Degrees gravity (oil).
‖ Thousand cubic feet (gas).
** Barrels per hour (oil).

Of the newly discovered gas fields two have necessary qualifications to warrant additional drilling or development in the hopes of justifying the installation of re-cycling plants. Three of the gas fields possess a thin rim of oil at their outer edges but these oil columns are not of sufficient importance to have incurred steady drilling campaigns.

It is interesting to note that the accumulations in at least fourteen of these thirty discoveries are the results of sand lenses in areas of monoclinal dips.

DISTILLATE OR CONDENSATE PRODUCTION

Until recently most gas wells yielding condensate or distillate were allowed to produce regardless of their high gas-liquid ratio and the gas was "blown to atmosphere." In the last few years legal bodies have enacted regulations defining this practice as wasteful, and condensate wells were denied the right to produce if tail gases were wasted. The waste phase of this practice has been eliminated by the construction of re-cycling projects wherein commercial condensates are extracted and the stripped gas is re-pressured sufficiently to return it through input wells to the original reservoir. This system of operations is a definite aid to conservation in that pressure maintenance allows a larger percentage of condensate to be recovered.

At the end of 1939 three major re-cycling units and one smaller unit were operating at Agua Dulce, Nueces County. At La Blanca, Hidalgo County, five wells were producing gas from which the condensates were extracted. These plants process 250 million to 275 million cubic feet daily and extract therefrom an average of 4,000 barrels of commercial condensate. Two additional plants are under construction at Agua Dulce which when in operation will increase the daily yield to about 5,700 barrels.

Despite the large number of gas reserves in South Texas, few possess the several necessary requisites for successful re-cycling projects.

Should all known condensate reserves in South Texas be prudently developed their total daily yield will not exceed 12,500 barrels. This would increase the 1939 production less than 5 per cent.

Information necessary to determine the amount of condensate in place has been obtained on twenty-one gas sands in seven major gas reserves. The total condensate in place in these formations averages 35 barrels per acre foot.

Prior to January 1, 1940, no condensate reserve favorable for re-cycling has been discovered in the San Antonio or Laredo districts. All known favorable re-cycling prospects produce from post-Eocene beds.

WILCOX DEVELOPMENT

During the past few years continuous exploration work has been done by major companies in those areas where the Carrizo or Wilcox formations may be expected at rational depths. This work did not crystallize into an active play until 1939 and resulted from the Wilcox discovery at Eola in southern Louisiana. Several Wilcox tests were attempted but the two important ones were in the Bruni pool, Webb County, and West Tuleta pool, Bee County, where definitely closed structures were producing in shallower beds. Due to mechanical troubles these two wells never reached their goal but showed oil or gas in the Claiborne.

Actually, little information was acquired during the year pertaining to the Wilcox; however, the test at Bruni did confirm the previous suspicion that the Claiborne beds thicken appreciably toward the south and that the Wilcox strike swings west of the strike in the upper Eocene beds.

One development, resulting from the added interests in the Wilcox trend, has been a revival of attention to surface geology.

"SLIM"-HOLE DRILLING

"Slim"-hole drilling for geological purposes was inaugurated in this area in 1939. Core drilling has been, for many years, a means of acquiring geological information and more recently these holes have been drilled with no coring whatsoever, and electrical logs plus cuttings furnished bases for correlations.

Improvements in these types of rigs make it possible for test holes to be drilled to a depth of several thousand feet. This means of obtaining geological information is specifically applicable to the Gulf Coastal area because unconformities in shallower beds have obliterated much of the structure responsible for oil accumulation.

In these "slim"-hole deep tests no "rat-holing," coring, or drill-stem testing is attempted and all information acquired must result from cuttings and electrical logs.

NOMENCLATURE PROBLEM

Confusion has always existed regarding the nomenclature of subsurface formations present between the base of the Oakville and top of the Eocene. Due to lateral transitions and pinch-outs a major portion of this section has no counterpart exposed at the surface.

One of the major geological problems of the area is to correlate the various determinable zones developed in the subsurface to known surface outcrops, if such exist, and apply a diagnostic terminology to

them. Cross sections based on electrical logs are furnishing correlative information impossible to acquire heretofore.

The Houston Geological Society has done valuable work toward this end.

TECHNICAL ADVANCEMENTS

Certain technical practices pertinent to geological information are being used more and more. It is a rare event for a well, either in wildcat or proved territory, to be completed and not be logged electrically. The value of core analyses is becoming more widely realized as a direct adjunct to the determinations of oil or gas reserves.

Some Frio sands are cemented by calcareous substances which lower their permeabilities to the extent that their daily yields are below economic levels. Gas sands of this type at La Blanca, Hidalgo County, and Rincon, Starr County, responded to chemical treatments and are now commercial producers. Some experienced operators are dubious of its widespread advantages but the results previously mentioned are so definite that this method of abetting production should be given serious study.

Electrical logs ofttimes disclose favorable sands not detected during the drilling of wells. One means of determining values of these sands is to use side-wall coring. This has been entirely satisfactory in some instances but the technique has not yet reached the point of perfection to be considered entirely dependable.

OIL RESERVES

It is estimated that 79 million barrels of crude oil and condensate are known to have been discovered in 1939.

One hundred and sixty pools in South Texas comprise the unproduced reserve of 1,260 million barrels of crude oil.

The first ten major pools contain 55 per cent of the total reserves and the next ten contain 17 per cent.

Based on the rate of last year's production present reserves are equivalent to 15.5 years supply.

Sixty-eight per cent of all discovered crude is unproduced.

Present reserves are 300 per cent more than on January 1, 1934. It is of interest to observe that the rapid increase in reserves immediately followed the introduction of electrical logging.

PAST PRODUCTION

Figure 3 shows the annual production of oil in South Texas since 1922 and the percentage of national production for which South Texas

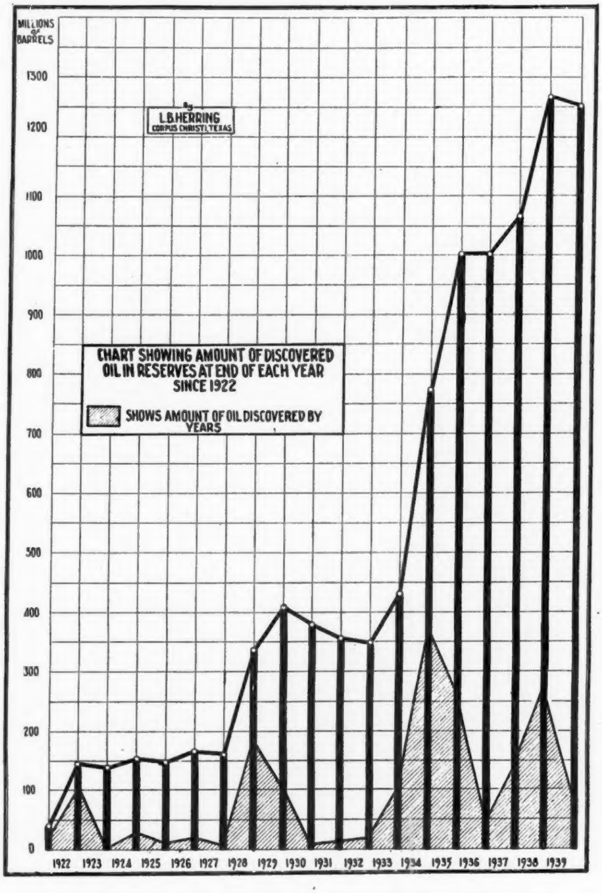

FIG. 2

has been responsible. With the discovery of the Luling field, Caldwell County, production rose from a few hundred thousand barrels to 15 million and gradually declined after 1925 until the Refugio, Salt Flat, and Darst Creek fields were discovered. In 1930 the annual yield rose to 34 million barrels. Over-production, with its incidental collapse of crude prices and local endeavors at proration, caused a rapid decline in output till proper legal authority to equalize supply and demand was delegated regulatory bodies. A fair value for crude

was established and during the next 5 years (1933–1938) South Texas production increased 400 per cent.

There have been annual decreases in production during the last

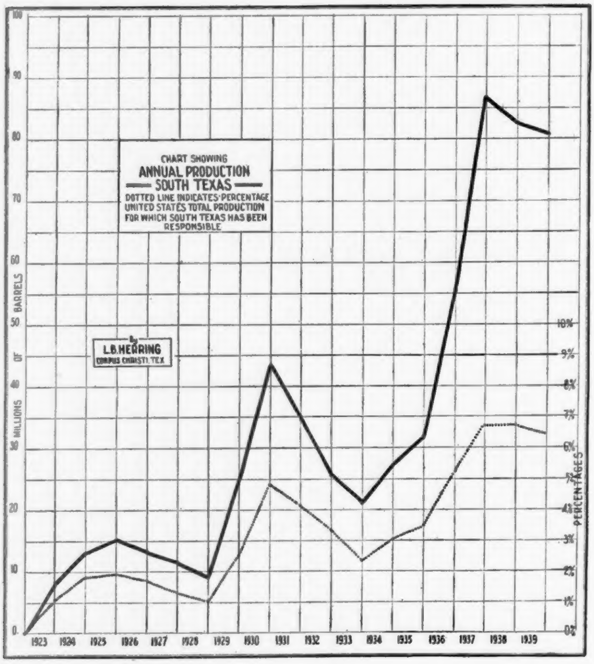

FIG. 3

2 years. The Laredo and San Antonio areas have been responsible for both of these.

Figure 3 shows a uniformity of percentage increases with each of the succeeding three "highs" and "lows" and suggests that this area will improve its position as a national figure.

GEOLOGICAL DISTRIBUTION OF RESERVES

Post-Eocene.—No production of importance has been found in beds younger than Catahoula.

Three pools producing from the upper Catahoula will eventually yield more than 10 million barrels each. Although this zone is not responsible for large reserves the present tendency is to increase them slightly.

TABLE II

GEOLOGICAL DISTRIBUTION OF RESERVES, PERCENTAGES OF RESERVES MAJOR ZONES ARE RESPONSIBLE FOR, AND PERCENTAGES OF DISCOVERED OIL UNPRODUCED

	Zone	*Barrels of Oil Reserves January 1, 1940*	*Percentage of Total Reserves*	*Percentage Ultimate Yield Unproduced*
CORPUS CHRISTI DISTRICT POST-EOCENE PRODUCTION	Catahoula *Discorbis* zone	40,116,000	3.18	42.38
	Heterostegina zone	205,463,000	16.30	83.04
	Marginulina zone Upper Frio or Lower Catahoula Lower Frio or Vicksburg	672,967,000	53.41	85.09
	Vicksburg			
LAREDO DISTRICT (INCLUDING BEEVILLE AREA) EOCENE PRODUCTION	Fayette or Whitsett (upper Jackson) *Textularia hockleyensis* *Textularia dibollensis* Cockfield Yegua	254,693,000	20.21	57.06
	Cook Mountain Mount Selman Carrizo Wilcox Midway			
SAN ANTONIO DISTRICT PRE-EOCENE PRODUCTION	Navarro Taylor			
	Serpentine	4,688,000	.37	17.07
	Austin Eagle Ford Buda Del Rio Georgetown			
	Edwards	69,906,000	5.55	27.05
	Unclassified	12,270,000	.98	27.05
	Total	1,260,103,000	100.00	

Six pools in the *Heterostegina* zone are responsible for 95 per cent of its discovered reserves. The present tendency is to increase reserves in this zone.

Forty-nine pools produce oil from the upper and lower Frio. Nine of these are estimated to have an ultimate yield of more than 25 million barrels each. Most adjustments of estimated reserves in these sands have been downward. As these zones are only 14.9 per cent depleted many additional adjustments may be anticipated.

As stated previously much confusion exists in nomenclature of producing zones in the Corpus Christi area. The Vicksburg is an accepted zone but differences of opinion exist as to the stratigraphic position of its top.

Well developed sand sections immediately above the first *Textularia warrenii* are the oldest beds in the post-Eocene section which furnish economic production. These sands are termed Frio by some and Vicksburg by others.

No commercial production has been found between the top of the *Textularia warrenii* and the Eocene.

Eocene.—Six of the sixty-seven pools producing in the Laredo area are estimated to yield eventually more than 25 million barrels and eight other pools are expected to yield between 10 million and 25 million barrels each. These fourteen pools possess 78 per cent of total estimated oil reserves in that area.

Pre-Eocene.—Serpentine production occurs in sixteen fields totaling 3,570 acres and will average 7,000 barrels per acre. This zone is 82.3 per cent depleted.

The Edwards limestone is producing in five fields from 5,515 acres and will recover an average of 40,000 barrels per acre. This formation is 72.5 per cent depleted.

Since a large portion of oil discovered in the Edwards limestone and serpentine is a matter of record, determinations of their per acre yields should be relatively accurate.

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REVIEW OF DEVELOPMENTS IN 1939, GULF COAST OF UPPER TEXAS AND LOUISIANA[1]

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ABSTRACT

The discovery record for 1939 has again failed to keep pace with the more successful years prior to 1938. Of the 23 new fields listed, it is probable that no more than three or four will ultimately justify a major rating. The intensive activity that was anticipated for the Wilcox zone has resulted in the discovery of only one new field and the deepening to production in this zone in two fields already producing from younger sands.

Low-relief traps associated with faulting have become an increasingly important source of new reserves. An explanation is offered as to the possible relationship of these structural types to major salt movements.

The development of important oil deposits on the flanks of old producing fields has been an outstanding feature of the year.

INTRODUCTION

Developments in the Gulf Coast district during the year 1939 have differed in no important sense from those of previous years. The number of discoveries has diminished somewhat, with 10 for Texas and 13 for Louisiana, and the quality of discovery has depreciated greatly; but this is a result to have been anticipated after the years of intensive exploration to which this region has been subjected. It has been pointed out elsewhere that there has been a gradual change, from year to year, in the viewpoint of the operator toward the problems of oil finding. This has been brought about because the majority of major structural traps can be considered as already localized and there is consequently necessity of concentrating the search on features of a much less pronounced type. The assertion that new major structural features are becoming scarce is attested by the fact that out of 23 new discoveries for 1939, no more than three or four may tentatively be given such a rating today.

The decrease in the discovery rate of virgin pools has resulted in a gradual increase in the exploration for flank extensions and deeper sands in old pools. This exploration has met with considerable success, particularly during the past year. The discovery of prolific production in thick flank sands of Vicksburg age at Thompsons, Fort Bend County, is one of the outstanding accomplishments that has resulted from this campaign. In the past, the Vicksburg has been regarded as a stratigraphic unit with only minor oil potentiality, but

[1] Read before the Association at Chicago, April 12, 1940. Manuscript received, March 6, 1940.

[2] Consulting geologist, 804 Second National Bank Building. Acknowledgment is due Paul Weaver for assistance in working out some of the ideas expressed in the introduction and for criticism of the developments data.

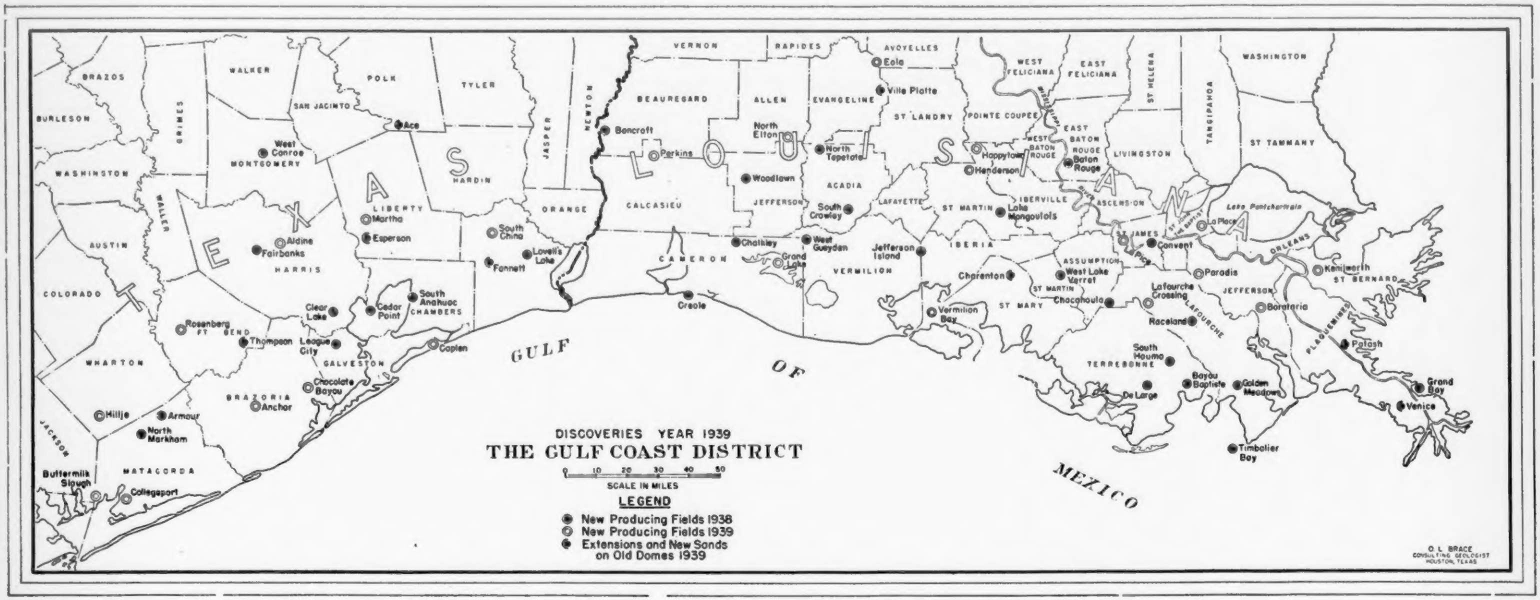

FIG. 1.—Map of Gulf Coast district showing new producing fields discovered during 1938; and new producing fields, extensions, and new sands on old domes, discovered during 1939. Previously discovered fields and domes are omitted in order to preserve legibility of map.

the discovery at Thompsons indicates that sands of this age may become an important factor where found under proper conditions of occurrence.

In the detailed description of discoveries that follows, it is noted that a considerable number of the new fields are of the low relief, faulted type. In fact, structural units of this character have been an important factor in the discovery column for the past several years and it is generally recognized that they are to occupy a position of greater importance in the future. During the years 1936 to 1938, several of these minor relief features, including Amelia, Cheek, and Lovells Lake, were discovered in close proximity to each other, in northern Jefferson County. During 1939, a fourth field, South China, was added to this group. These fields all occur associated with minor folds, where faulting is a predominant factor in affecting updip closure, with the trap usually formed against the downthrown side of such faults. During the same period, a similar group of fields was uncovered in Chambers County, including Cotton Lake, South Cotton Lake, and Cedar Bayou, where structural conditions have a resemblance to those in Jefferson County. Elsewhere along the coast, particularly on the Texas side, there are isolated wells and small fields that offer a suggestion of being controlled by structural conditions of similar nature and it is certain that oil accumulations following this pattern will eventually be found at numerous localities within the district.

An explanation of the causes behind the structural development of these low relief groups which occur in the so-called interdomal areas is a probable relation to salt movement during the building of the major piercement salt masses that are located around the margins of these areas. It is postulated that the extraction from the mother salt beds of the material necessary to build these tremendous salt cores has created unstáble conditions in the deep-seated beds that are adjacent to them. According to some opinion, these fields are localized through the influence of faulting, regardless of the proximity of piercement domes. There are other views to the effect that instability of margins of the rim synclines of the piercement domes has caused wrinkles and faults, and they may, therefore, be thought of as incipient salt uplifts. On the basis of this theory, it is reasonable to anticipate that minor crumpling and faulting will be found at localities that coincide with the margins of such major salt withdrawals and the two areas in Jefferson and Chambers counties mentioned are in fact near piercement domes. Other testing of interdomal areas is proceeding and the recent drilling near Rosenberg in Fort Bend County seems to show structural characteristics of a similar type.

At the close of 1938, the discovery of Wilcox (Eocene) oil at several points along the inner margin of the coast, climaxed by the discovery of a prolific Wilcox field at Eola, fostered the belief that a very intensive campaign in 1939 would result in the location of numerous new areas producing from this formation. Although a modest exploratory campaign has been carried on throughout the year, no discoveries of note have materialized. In Louisiana, as a result of much geophysical work across this updip trend, a few structures are reported but the only positive success produced by actual drilling to date has been the discovery of Wilcox oil beneath the regular Sparta pay zone at Ville Platte, Evangeline Parish. On the Texas side, one positive result can be set out for the year: the deepening to Wilcox production at Ace, Polk County. Other areas, scattered along the coast as far southwest as the Laredo district, have furnished slightly encouraging indications, but with no commercial discoveries. As this is written, two tests in Montgomery County and one in Colorado County, have logged minor showings in Wilcox sands and each is still in the process of testing.

Two factors so far have been unfavorable for the possibility that the Wilcox formation may rival the Frio or the Yegua as a source of reserve oil. In the downdip zone, where the Wilcox is to be encountered at depths ranging from 8,000 feet to 11,000 feet, sands are relatively poor. Wells penetrating the formation in this area have found large bodies of sand, but these sands are very low in porosity and permeability and are barren or contain gas. At a position farther inland, where sand conditions are not necessarily a problem, the unfavorable factor is the absence of structure. This generalization may not be applicable to the southwestern Gulf Coast but it certainly has a pronounced bearing on the potentiality of the zone eastward from Colorado County, and across Louisiana to the Eola field.

In an effort to make an advance appraisal of the 1939 discoveries based on the meager data that are available at the close of the year, it may be enlightening to consider the present status of the discoveries of 1938. During that year, 29 new productive areas were found; 20 in Louisiana and 9 in Texas. At the end of 1939, after nearly 2 years of exploitation, the status of the Texas discoveries is still very unsatisfactory. Two of these areas, West Conroe and South Anahuac, have not progressed beyond the initial discovery stage. Two other discoveries, Armour and North Markham, have completed no more than four producing wells each. The remaining five have developed into productive areas of importance but only Fairbanks may be regarded now as justifying anything approaching a first class rating.

The record of Louisiana is no great improvement over that of Texas. One new 1938 discovery, South Crowley, has developed no commercial wells. Eight areas, including North Tepetate, South Houma, Convent, West Lake Verret, Vermilion Bay, DeLarge, Bayou Baptiste, and Timbalier Bay, have two or less producing wells each at the end of 1939. Four new areas, consisting of West Gueydan, Jefferson Island, Raceland, and Chacahoula, have four producers each, while the remaining seven fields have wells to their credit that range in number from 57 for Baton Rouge to six for Grand Bay. Despite the passage of time and the large amount of development, it is still impossible to advance a reasonably accurate estimate of total reserves represented by the majority of these areas. The criterion established by the rather disappointing development of the 1938 discoveries, and the similarity of initial performance of the 1939 discoveries to those of 1938, seems to justify the prediction that few of the new areas brought into production during the past year will justify an ultimate rating as first class petroleum reserve units.

DEVELOPMENTS

It has been the accepted plan to group developments under the stratigraphic section in which they occur and to discuss them in this order. This plan is continued for 1939. Due to the very active character of the district, the limited scope of this paper necessitates that treatment of the background of new discoveries be confined to bare essentials.

CONROE TREND

The Conroe trend incorporates the updip zone, following the inner margin of the coastal region, where production is to be anticipated from beds of Wilcox and Cockfield-Yegua age. At the beginning of the past year, it was anticipated that this zone would be unusually active, due to discovery of Wilcox production at several points along the trend. A minor amount of activity has materialized, but the results of prospecting have been essentially discouraging.

Discoveries for the year do not include any new Cockfield-Yegua fields. One new Wilcox field, Eola, was reported in the 1938 review, and this is now to be regarded as an outstanding discovery. Important new deep sands were also opened for production at Ace in Polk County, and at Ville Platte, Evangeline Parish.

Eola.—This new Wilcox field in Avoyelles Parish was found by Sid Richardson. The discovery well, Haas Investment Company No. 1, was completed in January, 1939. Well developed Wilcox sands encountered at 8,440 feet made a large initial flow of 43° gravity oil.

Structural delineation resulted from torsion-balance and reflection-seismograph study. This discovery initiated a very active search for additional unmapped structures along this trend but no further successes were registered during the year.

INTERMEDIATE ZONE

The intermediate zone is a coastward continuation of the Conroe trend and it is normally anticipated that productive areas lying within this strip will produce from sands of Cockfield-Yegua age. A moderately active year resulted in the discovery of three new fields in Texas and four in Louisiana.

Rosenberg.—In September, 1939, H. C. Cockburn, an independent operator, completed the Dzierzanowski No. 1, located in western Fort Bend County, as a small, high-gravity oil well in the *Eponides* (Yegua) sand at 7,735–43 feet. While coring the sand, pipe was stuck and cemented in the hole, so that little is known about the producing formation in this test. This is an old gravity prospect, with the reflection seismograph used by Cockburn to guide the first location.

At the close of the year, the Magnolia Petroleum Company completed a gas and distillate well that is still of questionable commercial importance, located 3 miles northeast of the Cockburn discovery. The producing formation at 8,246–8,250 feet lies 450 feet below the *Eponides* sand. This may or may not be a part of the Rosenberg structural feature. Credit for this extension is partially due to Subterrex for having recommended deeper drilling on data furnished by geochemical well-logging.

Aldine.—Aldine, located in north-central Harris County, was discovered by the Texas Gulf Production Company's Weary No. 1, on May 6, 1939. The sand at 6,824–6,834 feet is Yegua in age. Since discovery, four dry holes and one gas well have been completed.

This is an old torsion-balance prospect that was worked shortly prior to development by the reflection seismograph. The details of local structure are imperfectly understood but it is possible that accumulation occurs against a fault that is downthrown coastward, a northeast continuation of the Fairbanks structural trend.

Martha, in Liberty County, is an area of moderate importance that was discovered by the Stanolind Oil and Gas Company in July, 1939. The discovery well, Flowers No. 1, was completed in the Yegua sand at 8,104–8,108 feet, producing 241 barrels of 41° gravity oil daily. At the end of the year, four or five oil wells and two dry holes had been completed. Sands are thin and per-acre recoveries are to be small. The Martha structure was isolated during the Stanolind's intensive geophysical campaign of 1935–1936.

Of the four Louisiana discoveries that are credited to this zone for the year, none shows promise of oil reserves of more than secondary importance.

Perkins.—This new area in Calcasieu Parish was found by the Humble Oil and Refining Company on August 2, 1939. The discovery well, Edgewood Land and Log Company No. 1, completed in Oligocene sand at 9,038–9,042 feet, produced gas and distillate. Abnormal local structural conditions were indicated by the reflection seismograph in 1938–1939. Two dry holes have been drilled since discovery.

North Elton, located in southeast Allen Parish, was isolated with reflection shooting by the Bel Oil Corporation. Their Bel Estate No. 1 was completed as a gas and distillate well in the *Marginulina*-Frio sand at 7,272–7,292 feet on June 14, 1939. Insufficient data are yet available to permit an appraisal of this discovery but its potentialities do not appear promising.

Happytown, St. Martin Parish, was discovered by the Shell Petroleum Corporation's Iberville Land Company No. 1 in November, 1939. Sand of Frio age was cored from 9,747 to 9,767 feet and the completed well gauged 1,013 barrels of 39.3° gravity oil through $\frac{1}{4}$-inch choke daily. This is a fault trap of the Tepetate type that was isolated as a result of gravity and reflection study. The one producing well does not permit an evaluation of the reserves represented in this new area.

Henderson.—This discovery in northern St. Martin Parish was mentioned in the review of 1938 but satisfactory completion of the discovery well did not occur until September, 1939. Henderson, a pronounced dome with salt lying at 8,800 feet, was first found by the Texas Company, with the aid of geophysics, in 1934. Since that time, nine deep dry holes were drilled. The tenth test, St. Martin Land Company No. 12, found salt at 8,848 feet and was plugged back for completion in Oligocene sand at 8,570–8,590 feet. A second well is now drilling.

DEEP COASTAL ZONE

As in previous years, the deep coastal zone furnished most of the new discoveries. This fact may be attributed to the greater width of territory included within this zone and to the overlap of a thick section of oil-bearing Miocene sediments that are essentially nonpetroliferous in their occurrence across the updip intermediate and Conroe zones. There are fifteen new productive areas within this lower zone, seven in Texas and eight in Louisiana. Of the Texas discoveries, four have only one producing well each at the end of the year and only two of the seven appear to represent reserves of any consequence.

The record of Louisiana is somewhat more favorable but here, also, the outlook is none too promising.

Buttermilk Slough.—The Sun Oil Company's Cavallin No. 1, Matagorda County, was completed on July 20, 1939, in the Frio sand at 7,850–7,860 feet. It was drilled to 9,582 feet but was plugged back and completed as a gas and distillate well with a large quantity of salt water. No additional producers were completed during the year and the area seems unimportant. Discovery resulted from reflection-seismograph work and little is known about the details of structural occurrence.

Hillje.—This Wharton County area has been indicated as a possible new commercial oil field by completion of The Texas Company's Peters No. 1 on September 10, 1939. Frio sand at 5,220–5,230 feet yielded 14 barrels of 25° gravity oil daily. No other wells have been drilled. The discovery location was made on reflection-seismograph information.

Collegeport is a new field located in southwest Matagorda County. The Continental Oil Company made location for their Stewart Savage No. 1 on favorable reflection-seismograph information, and the well was completed on July 15, 1939, in Miocene sand at 4,132–4,143 feet, making about a million cubic feet of wet gas daily. Two additional gas wells have been completed at about the same depth.

Anchor.—Anchor, Brazoria County, is probably the most promising East Texas coastal discovery of the year, although very little is yet known as to the potentialities of the area. Glenn McCarthy's Carr No. 1 was completed on September 28, 1939, as a gas and distillate well in the Frio sand at 10,460–10,467 feet. Later, the Humble completed an oil well located 1.5 miles distant and this indicates that the producing area includes 2,500 acres.

Anchor was mapped with torsion balance and reflections by numerous companies and was leased by the Humble Oil and Refining Company. The McCarthy well was drilled on acreage farmed out by the Humble, after they had completed two deep dry holes. The discovery well is the second deepest producer in the state.

Chocolate Bayou.—This Brazoria County area has had indications of commercial oil but is not yet to be classed as a proved field. McCarthy and Plummer's Houston Farms No. 1 cored saturation in the Frio sand at 9,865–9,875 feet in August, 1939. It was plugged back from a total depth of 10,381 feet. Initially completed for 25 barrels of oil per day, the well has had to be reworked several times and it is still not a satisfactory producer. Chocolate Bayou is an old torsion-balance anomaly that was detailed with the reflection seismograph by McCarthy.

Caplen.—This new field, located on Bolivar Peninsula in Galveston County, was discovered by the Sun Oil Company in March, 1939. The discovery well, Cade No. 2, was drilled after three dry holes had been completed. The sand at 7,474–7,478 feet is basal Miocene in age. Only four small oil wells have been completed but the area shows a major amount of structural relief and it is tentatively regarded as important.

South China.—This Jefferson County area was isolated as the result of a general reflection-seismograph survey by the Sun Oil Company. The structure is of a low relief, faulted type, similar to Amelia and Lovells Lake. The discovery well, Fontenot No. 1, was drilled by Hebert, Smith, and Echols on leases farmed out by the Sun. Production was found, in June, in the Frio sand at 7,872–7,885 feet, approximately 1,000 feet below the top of the Frio zone. The discovery well produced 202 barrels of 37° gravity oil per day through $\frac{1}{4}$-inch choke.

Since discovery, three additional wells have been completed. Development is hazardous because of faulting and erratic sands. At present the area does not appear to justify a first-class rating but it is probable that it should be ranked next to Anchor in relative importance for the discoveries of the year.

The new 1939 productive areas for deep coastal Louisiana are as follows.

Grand Lake, Cameron Parish.—The Superior Oil Company of California's State No. 1 produced oil from Miocene sand at 8,365–8,392 feet on May 6, 1939. The initial production was 384 barrels of 33° gravity oil per day. This discovery is a water prospect lying in Grand Lake that was first isolated after geophysical study by the Pure Oil Company. It is a faulted dome somewhat of the character of Creole, a discovery of 1938, located in the Gulf off the Cameron Parish coast, and appears to have considerable merit. By the end of the year, four wells had been completed.

Vermilion Bay.—This prospect, located in the water adjacent to the Iberia Parish coast, was discussed in the 1938 review. In that place it was mentioned that an exploratory well had blown out and cratered during the year.

In July, 1939, The Texas Company completed State B-3 in Miocene sand at 10,131–10,241 feet, producing 300 barrels of 32° gravity oil per day. The oil has a high gas ratio but as the sands are thick and the area of the dome appears to be large, the field may be regarded, at this time at least, as having a high potentiality.

La Pice.—The Shell Oil Corporation discovery in St. James Parish has one gas and distillate well at the close of the year and little that is favorable is known about its potentialities. The discovery well, Schex-

neyder No. 1, was completed in June, 1939, in Oligocene sand at 10,910–10,915 feet, after being plugged back from 11,314 feet, producing 48 barrels of distillate daily. The Schexneyder No. 1 was located on data furnished by torsion-balance and reflection-seismograph study.

LaFourche Crossing.—The discovery well at LaFourche Crossing, northwest LaFourche Parish, was completed, September 15, 1939. The Mikton Oil Company's Martinez No. 2 found commercial oil in Miocene sand at 10,128–10,132 feet. A second test is now drilling. Gas seepages and paraffine beds led to initial exploration and the presence of a domal type uplift was indicated by torsion-balance and subsequent reflection-seismograph investigation. Despite favorable structural conditions, the area can not be given a first class rating on the basis of the first well, because of poor sand conditions.

La Place.—This area, lying east of the Mississippi River in St. John the Baptist Parish, was found by the Shell Oil Company as a result of torsion-balance and reflection-seismograph exploration. The Shell drilled one dry hole to a depth in excess of 11,000 feet. The Pan American Production Company drilled the discovery well, Mills No. 1, on a farm-out from the Shell. The well was completed on November 25, 1939, in Oligocene sand at 8,115–8,122 feet, producing gas and 131 barrels of 60° gravity distillate daily. No new locations had been announced at the close of the year.

Paradis.—This important discovery by The Texas Company is located in St. Charles Parish. The discovery well, Louisiana Land and Exploration Company No. 1, was completed on June 26, 1939, in Miocene sand at 9,895–9,915 feet, producing gas and 120 barrels of 54° gravity distillate daily. Subsequently, a second well, located 1.5 miles northwest, was completed by the same operators in a sand at 10,340 feet with a potential of 1,760 barrels daily on ½-inch choke. It is reported that 200 feet of saturated sand was logged in this test.

This is the result of reflection-seismograph work and may be the most important coastal Louisiana discovery in the past several years. It is estimated by some observers that the producing area may include 6,000 acres.

Barataria.—This Jefferson Parish prospect was mapped by the California Company's reflection-seismograph work. The discovery well is The California Company's Adams Rutley No. 1 completed on November 2, 1939, producing 888 barrels of oil per day on ¼-inch choke. The discovery formation is a thin Miocene sand at 8,204–8,214 feet. Like most of the new fields along the coast, appraisal is difficult in the early stages of development. Sand conditions in the one well at Bara-

taria are poor but the structural area is large and better sands may be found elsewhere on the dome. There are now three active locations.

Kenilworth.—This St. Bernard Parish discovery was made by the Vendome Petroleum Company on May 5, 1939. The Kenilworth No. 1 was completed as a small oil well producing a large quantity of salt water in a sand of Miocene age at 10,600–10,610 feet. The well was temporarily abandoned after several attempts to shut off the water but it has since been reconditioned and is now a commercial well producing a small amount of oil and water. Surface soil analysis and reflection-seismograph work by the Vendome during 1938–1939 led to the discovery location.

IMPORTANT NEW SAND DEVELOPMENT

In Texas, the discovery of new sands in conjunction with old producing areas, has presented possibilities for adding to reserves that compare favorably with those of the new discoveries. At *Thompsons*, Fort Bend County, H. M. Naylor found important production in Vicksburg sands at 7,703–7,800 feet on the north flank of the dome, and the Gulf, the Humble, and others have developed a new upthrown fault block off the south flank in regular Miocene and Frio sands. These have added greatly to the reserves of this field. At *Esperson*, Liberty County, the General Crude Oil Company has found production on the south and southeast slopes of the dome in a thick sand series, probably Yegua in age. These sands, encountered between depths of 7,000 and 7,600 feet, are missing on top of the uplift, indicating lensing or truncation. At *Fannett*, Jefferson County, where past production has been confined to Miocene sands located on the south and east flanks, between depths of 2,900 and 4,500 feet, the Gulf Production Company discovered commercial oil and gas in the Frio during the month of August. The discovery well, located on the west side of the dome, was completed in a sand at 7,467–7,480 feet, above salt at 7,846 feet, producing 100 million cubic feet of gas and 200 barrels of distillate daily. The second well made a similar production. The third completion found oil in the Frio sand at 8,275–8,285 feet, above salt at 8,296 feet and gauged 425 barrels of oil in 12 hours on $\frac{1}{4}$-inch choke.

The search for Wilcox oil along the inner margin of the Texas coast has been pursued actively throughout the year but has resulted in only one discovery. At *Ace*, Polk County, where small production had previously been obtained in the Yegua, Peyton Brothers drilled their Kirby-West No. 1-C, to the Wilcox at 7,748–7,762 feet. An initial production of 395 barrels of 34° gravity oil resulted.

In Louisiana, *Ville Platte,* Evangeline Parish, may be regarded as having registered the most important new Wilcox sand development of the year. This field is an important Sparta sand producer and the discovery of Wilcox oil at Eola led to deeper drilling at Ville Platte. The discovery well for this horizon is the Continental Oil Company's Haas Investment Company No. 2, which encountered a good production of 53° gravity oil in the Wilcox sand at 10,055–10,085 feet, with the top of the zone logged at 9,875 feet. Three Wilcox wells have been completed to date.

At *Venice,* Plaquemines Parish, new deep production was found by the Tidewater in a sand at 10,610 feet. This sand makes the sixth commercial depth in the field. Both *Golden Meadows,* LaFourche Parish, and *Charenton,* St. Mary Parish, have furnished new sands during the year that materially increase the reserves for these pools. At Charenton, a considerable area of production has been developed on the west slope in sands at 1,100 and 1,800 feet, in what is known locally as the West Charenton field.

Potash, Plaquemines Parish, reported as a discovery for 1937, developed the first stable commercial oil production during January, 1939, when the Humble completed Orleans Levee Board No. 1. This well found saturated Miocene sand at 8,060–8,070 feet and showed an initial production of 20 barrels of 28° gravity oil hourly on $\frac{1}{4}$-inch choke. A number of other south Louisiana fields have had their status improved by development of production in sands other than the discovery horizon.

IMPORTANT EXPLORATION

On the Gulf Coast, commercial oil and gas occurs associated with a wide variety of structural types. These include deep-seated and piercement salt domes, faults, and low relief folds where faults are an important factor in affecting closure. The condition of oil occurrence that is being most intensively sought from year to year, depends to a certain degree upon the type of exploration that has resulted successfully in the current period. In 1936, the opening of prolific production on the flanks of Jennings, Acadia Parish, lent encouragement to flank-development projects, and important discoveries at West Columbia, Thompsons, Esperson, and elsewhere have followed. The fact that flank oil on the north slope of Thompsons dome is derived from sands of Vicksburg age, has led to the projection of tests through the Frio section in search of these horizons in other areas. At Fairbanks, Harris County, discovery of a field where the productive area is abnormally elongate in a strike direction, has led to a modified trend play.

The complexities of structural development on the Coast are best exemplified in the piercement dome. Many of these structures are characterized by a fault system where movement subsequent to the migration of oil has created alternate productive and barren segments on the same uplift which can not be differentiated in advance of drilling. There are also instances where the steeply dipping posture of the flank sands results in the occurrence of prolific productive bands that are narrow and consequently difficult to locate. Despite these hazards, operators are constantly returning to these frequently drilled domes in hopes of discovering one of the prolific flank deposits that have been proved so profitable.

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DEVELOPMENTS IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA DURING 1939[1]

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El Dorado, Arkansas, and Shreveport, Louisiana

ABSTRACT

Total annual production for South Arkansas and North Louisiana remained nearly the same for the year 1939 as for the year 1938. The decline of the Glen Rose production in the Rodessa field has been offset by the development of the Schuler field and the Magnolia field in Arkansas.

The main objective of prospecting centered on Smackover limestone production in southern Arkansas. No production to date has been found in the Smackover limestone zone in northern Louisiana.

PRODUCTION

The slight increase in production in southern Arkansas offsets the decrease in northern Louisiana so that the production for the North Louisiana-South Arkansas area as a unit during 1939 was only slightly less than during 1938. Production for these periods is as follows.

	1938 (Barrels)	*1939 (Barrels)*	*Number of Wells*
Arkansas	18,462,830	21,376,230	2,941
Louisiana	28,437,335	25,232,235	3,637
	46,900,165	46,608,465	6,578

The 250 wells drilled in southern Arkansas and the 528 wells drilled in northern Louisiana are analyzed according to type of well in Table I.

TABLE I

ANALYSIS OF PRODUCERS AND DRY HOLES DRILLED IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA DURING 1939

		In Proved Fields	*Wildcats*
Number oil wells completed	Arkansas	176	2
	Louisiana	285	3
Number gas wells completed	Arkansas	1	2
	Louisiana	83	3
Number dry holes completed	Arkansas	21	48
	Louisiana	106	48
Number wells drilling, January 1, 1940	Arkansas	27	17
	Louisiana	79	17

TREND OF PROSPECTING

The Smackover limestone continued to be the main object of prospecting in southern Arkansas while the lower Glen Rose and Cot-

[1] This article was prepared with the permission of C. O. Stark and D. E. Lounsbery, Phillips Petroleum Company, Bartlesville, Oklahoma. Manuscript received, April 26, 1940.

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ton Valley formations were the chief objects of prospecting in northern Louisiana. Table II is an analysis of wildcat wells indicating the deepest formations tested.

Geophysical work gradually declined during the year. There were 20 seismograph, 3 gravimeter, 1 magnetometer, 1 soil analysis, and 1 electro-magnetic crews reported in southern Arkansas during the year, with only 3 seismograph crews remaining in the state in January, 1940. There were 21 seismograph and 2 torsion-balance crews reported in northern Louisiana during 1939.

Table III indicated those dry holes drilled during 1939 which are considered of importance in that they have aided in establishing the limits of the Smackover limestone producing trend, the limits of possible producing area within the Cotton Valley section; or have afforded general structural or stratigraphic information not heretofore available.

Since January 1, 1939, the Smackover limestone has been penetrated by 10 wildcat wells in Arkansas and 3 wildcat wells in Louisiana. In addition to those mentioned in Table III, these include the following wells which have been completed since January 1, 1940: Barnsdall Oil Company's Cameron No. 1, Sec. 36, T. 19 S., R. 17 W., Union County, Arkansas; Union Producing Company's Tensas Delta Land Company No. 1, Sec. 8, T. 22 N., R. 4 E., Morehouse Parish; and Stanolind Oil and Gas Company's Dillon Heirs No. 131, Sec. 14, T. 21 N., R. 15 W., Caddo Parish, Louisiana.

The three wells drilled by the Shell, Deep Rock, and Lion in T. 15–16 S. (Table III) were located in the general area of the Arkansas "graben-fault zone." As in the case of some previous wells drilled along this zone, these particular wells encountered the oölitic zone in the Smackover limestone, only slightly permeable and containing salt water with showings of heavy dead oil. The wells drilled by Barnsdall, Oliphant, Standard, and Union had only a short section of porous oölite developed in the Smackover limestone. No oölite was developed in the Smackover limestone section in the Stanolind well.

Seven wildcat wells in Louisiana tested the possibilities of the Cotton Valley formation during 1939. Four of these were dry holes and only one may be classified as a commercial well. Outside of the Cotton Valley field, Webster Parish, the results of tests of the Cotton Valley formation have been disappointing.

There was one new discovery from the Glen Rose formation, the Lewisville field, Lafayette County, Arkansas. This discovery makes a total of four oil fields producing from the lower Glen Rose formation. Three predominantly gas-distillate fields are producing a small

TABLE II

ANALYSIS OF DEEPEST FORMATIONS PENETRATED IN WILDCAT WELLS DRILLED IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA DURING 1939

	Tertiary	Gulf	Comanche				Jurassic ?			Paleozoic	Salt Plug
			Fredericksburg	Paluxy	Glen Rose	Travis Peak	Cotton Valley	Smackover	Eagle Mills		
Arkansas	2	12	0	1	2	7	0	9	2	17	0
Louisiana	18	2	2	4	2	4	4	1	0	0	3

TABLE III

IMPORTANT DRY HOLES DRILLED IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA DURING 1939

County or Parish	Section-Township-Range Location	Company	Lease	Feet Total Depth	Deepest Formation Penetrated
		ARKANSAS			
Bradley	14-17S.-10W.	Amerada Petrol. Corp.	Bradley Lumber Company	5,310	Smackover limestone
Calhoun	17-14S.-13W.	J. R. Lockhart	Southern Kraft	5,007	Eagle Mills anhydrite
Columbia	4-17S.-21W.	Phillips Petrol. Co.	Rogers-Askew	8,510	Smackover limestone
Columbia	36-16S.-20W.	Standard Oil Co. of Louisiana	Warnock	7,778	Smackover limestone
Columbia	31-17S.-18W.	Twin City Syndicate	Hollensworth	7,858	Smackover limestone
Lafayette	13-16S.-24W.	Shell Oil Company	Warren	7,420	Smackover limestone
Lafayette	15-19S.-26W.	Wadley & Erwin	Taylor	6,801	Travis Peak
Mississippi	3-15N.-12E.	Benedum & Trees	Mack	4,335	Ordovician
Ouachita	23-15S.-19W.	Deep Rock Oil Corp.	Wesson	6,053	Smackover limestone
Ouachita	29-15S.-17W.	Lion Oil Refg. Co.	Annie	6,092	Smackover limestone
Union	13-18S.-12W.	Joe Modisett	Union Saw Mill (3)	6,290	Smackover limestone
Union	22-19S.-14W.	Oliphant Oil Corp.	Union Saw Mill	7,939	Smackover limestone
		LOUISIANA			
Bossier	19-19N.-13W.	Hanbury	Leonard	6,039	Travis Peak
Caddo	3-15N.-12W.	Prairie River Synd.	Hutchinson	6,010	Travis Peak
Caddo	29-17N.-13W.	Crawford	Lloyd	6,000	Travis Peak
Caddo	19-18N.-14W.	Driscoll	Woolworth	5,608	Lower Glen Rose
Caldwell	31-12N.-3E.	Arkansas Fuel Oil Co.	Louisiana Central Lumber	7,528	Trinity
Catahoula	33-11N.-8E.	Bell	Peck	5,023	Wilcox
Concordia	48-8N.-9E.	Addy	Pasternack	4,512	Wilcox
Franklin	22-13N.-8E.	Continental Oil Co.	Sherrouse	1,839	Salt
Franklin	26-13N.-8E.	Continental Oil Co.	Carroll	4,041	Salt
Madison	2-15N.-11E.	Continental Oil Co.	Singer	3,705	Midway
Natchitoches	17-10N.-10W.	Lent	Whatley	3,299	Paluxy
Tensas	31-13N.-12E.	Continental Oil Co.	Cammack	4,172	Salt
Union	14-23N.-2W.	Standard Oil Co. of Louisiana	Frost Lumber Company	8,755	Smackover limestone
Webster	30-18N.-8W.	Union Production Co.	Walker	10,383	Cotton Valley

amount of oil from this formation. The tendency for gas-distillate production from the lower Glen Rose formation is noticeable southward from Arkansas into Louisiana. This feature is well illustrated by the geographical distribution of the lower Glen Rose pools.

Two new salt-dome prospects were tested in Franklin and Tensas parishes with the usual negative results attending the interior piercement-salt-dome explorations in this area.

NEW FIELDS

Table IV lists the new discoveries made in southern Arkansas and northern Louisiana during 1939. The Arkansas discoveries were new areas for production while those in Louisiana were new deeper zones in old producing areas. Two discoveries were in the Reynolds porous oölite zone of the Smackover limestone, extending the limit of the zone farther southwest. Of the two discoveries from sands in the Cotton Valley formation in Louisiana, only one appears to be of commercial importance, apparently further limiting the production possibilities of this formation to the northernmost part of the state.

The discovery in the lower Glen Rose, while not of major importance as a reserve, is noteworthy in that it extends production from this formation considerably north of the previous fields. The Nacatoch sand gas well is of minor importance.

EXTENSIONS AND DEVELOPMENT

Arkansas.—Two small discovery pumping wells were completed in the Meekin and Graves sands in the Lawson area, Sec. 6, T. 18 S., R. 13 W., Union County, and are of little commercial importance. Seventy-six wells were completed in the Magnolia field, Columbia County, to bring the total to 82 producers. Ten wells were drilling at the end of the year and the field should be completely drilled by the end of 1940. The producing limits of the Schuler field, Union County, were practically defined by the end of 1939. The 37 additional wells drilled during 1939 make a total for the field of 11 Morgan zone, 141 Jones sand, and 16 Reynolds oölite producers. Village, Columbia County, was practically drilled up with 11 producers, while the limits of the Buckner field with its 19 producers are not completely outlined.

Atlanta, Columbia County, had 5 producing wells by the end of the year. With the area undefined, development will continue throughout 1940. Rodessa, Miller County, was practically developed by the end of the year, with pressures and production declining rapidly. There was very little development elsewhere in Arkansas in the older producing areas.

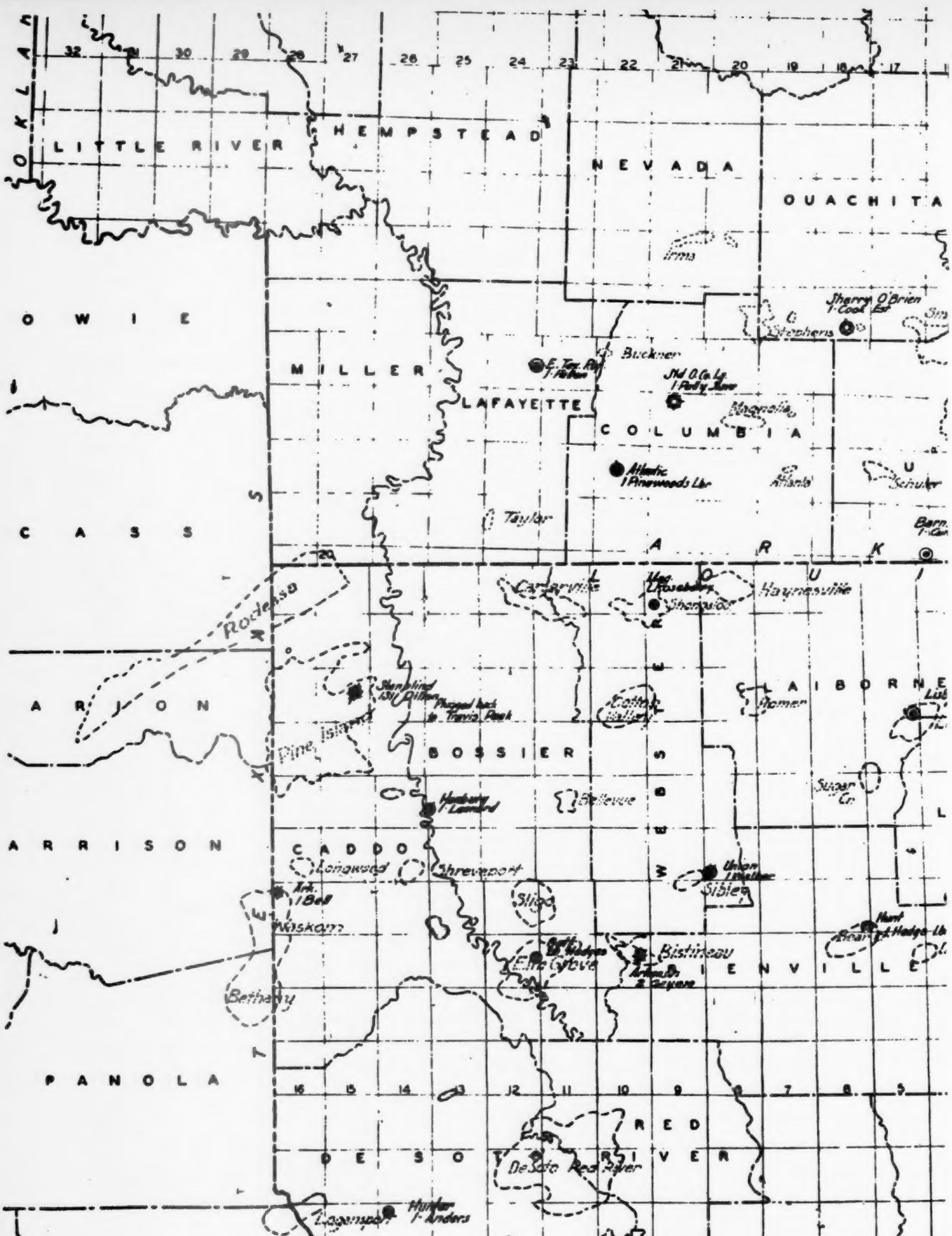
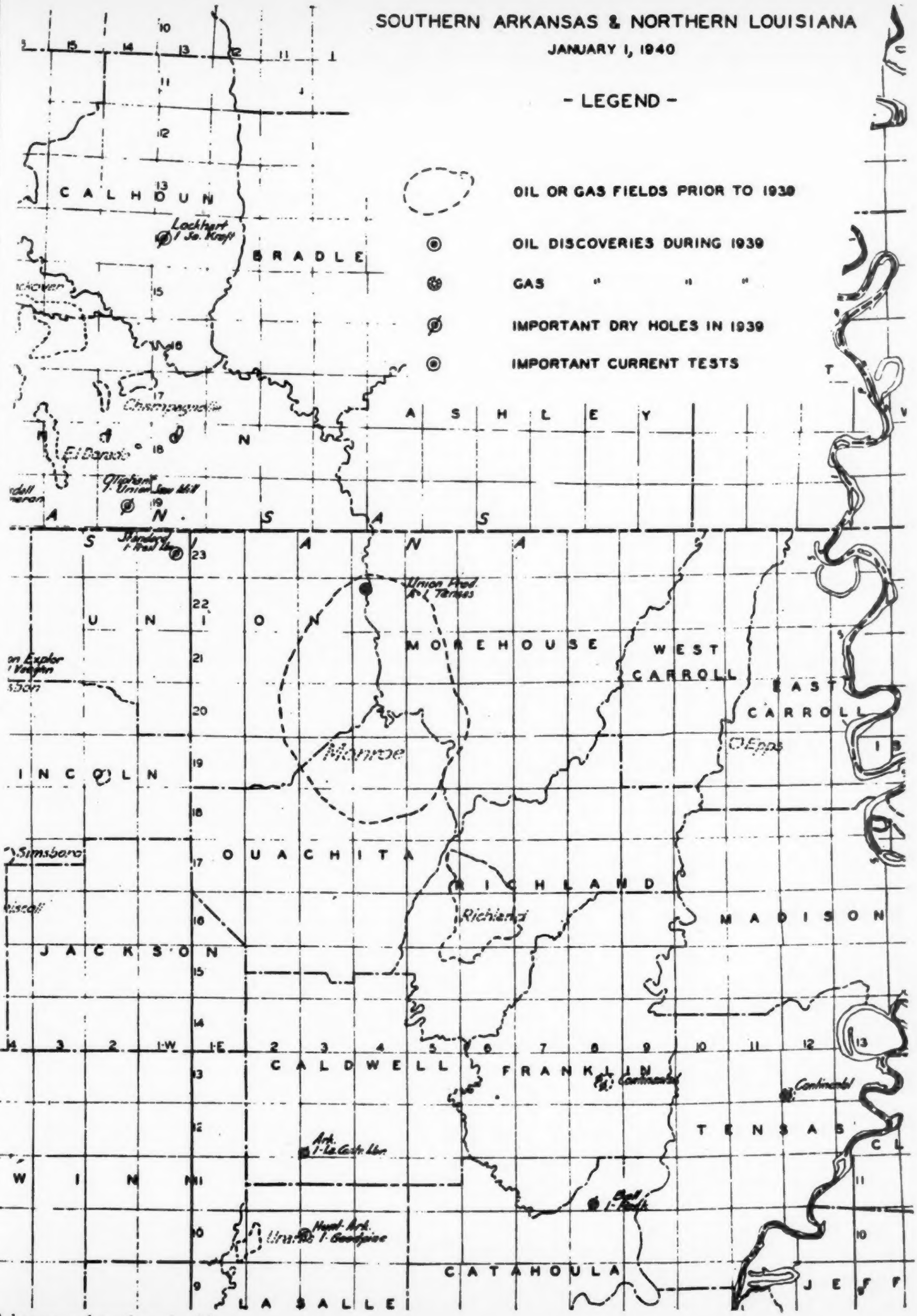


FIG. 1.—Oil and gas fields of southern



Arkansas and northern Louisiana.

TABLE IV

DISCOVERY WELLS DRILLED IN SOUTHERN ARKANSAS AND NORTHERN LOUISIANA DURING 1939

County or Parish	*Field*	*Location Sec.-Twp.-Rge.*	*Company*	*Lease*	*Top Producing Zone (Feet)*	*Age Producing Zone*	*Feet Total Depth*	*Initial Production Bbls. Per Day Oil or Thousand Cu. Ft. Gas*	*Producing Choke (Inches)*
				ARKANSAS					
Columbia	Big Creek	4-17S.-21W.	Standard Oil Co. of Louisiana	Petty Stave Co.	7,958	Smackover limestone	7,999	168 Bbls. 4,000 MCF.	$\frac{14}{64}$
Columbia	Dorcheat	16-18S.-22W.	Atlantic Rfg. Company	Pinewoods Lbr. Co.	8,815	Smackover limestone	9,002	528 Bbls. 2,000 MCF.	$\frac{18}{64}$
Lafayette	Lewisville	24-16S.-24W.	East Texas Refg. Company	Patton Estate	3,411	Rodessa member (Lower Glen Rose)	3,606	168 Bbls.	Open
Ouachita	West McDonald	27-15S.-18W.	Sherry O'Brien	Cook Estate	1,588	Nacatoch sand	1,618	20,000 MCF.	$\frac{32}{64}$
				LOUISIANA					
Bienville	Bistineau	14-16N.-10W.	Arkansas Fuel Oil	Gayoso	8,110	Cotton Valley	8,532	3,000 MCF.	Variable
Claiborne	Lisbon	36-21N.-5W.	Lisbon Exploration Company	Vaughn	8,444	Cotton Valley	8,901	64 Bbls. 54° 1,000 MCF.	$\frac{5}{16}$

Louisiana.—The Louisiana part of the Rodessa field is now almost fully developed and production from the Young zone of the lower Glen Rose is on the decline. A total of 470 wells were on production at the end of 1939. The total accumulated production for Caddo Parish Rodessa field is 61,055,975 barrels. The Shreveport field, the last Glen Rose oil discovery in northern Louisiana, has been defined by several dry holes. Fifty-one producers, 6 of which are gas-oil wells, 6 of which are dry, is the total number of tests drilled to the end of 1939 in this field. Accumulated production to January 1, 1940, is 1,977,480 barrels. The Lisbon field declined more rapidly than any other oil producing Glen Rose field in this district. This field had 230 wells at the end of the year with an accumulated production of 7,424,710 barrels.

At the end of the year the Cotton Valley field had a total of 146 deep wells completed and the field is about three-fourths developed. Completions and production are classified as follows.

	Barrels
43 Travis Peak oil wells	1,443,201
2 Travis Peak gas wells	
16 Cotton Valley "D" oil wells	761,206
10 Cotton Valley "Bodcaw" oil wells	715,453
77 Cotton Valley "Bodcaw" distillate wells	1,326,485

In considering the drilling depth, the Shongaloo field has been a disappointment. To date it has two gas distillate wells and one small oil well producing from zones 1,000 feet below the Bodcaw sand, the principal producing zone in the Cotton Valley field. The Arkansas Fuel Company completed a Travis Peak gas well in the Louisiana portion of the old shallow Waskom gas field, adding to the gas reserve of the area. Previously it had completed two Travis Peak gas wells on the Harrison County, Texas, side of the field.

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DEVELOPMENTS IN ROCKY MOUNTAIN REGION IN 1939[1]

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ABSTRACT

There were no relatively important oil and gas discoveries in the Rocky Mountain region in 1939 in unproved areas. One well in the southwest Pondera or Pendroy district, Teton County, Montana, produced a little oil from the Madison limestone, but was considered non-commercial and was saved as a gas well in the Colorado shale. The only other discovery in an unproved area was a relatively small gas well on the Horne Valley anticline, Carbon County, Wyoming, less than ½ mile southeast of a stratigraphically deeper dry hole.

The deepening of oil wells farther into the Tensleep sandstone resulted in relatively large oil production in the old Wertz gas field, Carbon County, Wyoming. In the Lance Creek field, Niobrara County, Wyoming, a rather widespread and prolific oil zone was found in the Minnelusa sandstone as much as 200 feet below the oil-producing Leo sand; and in the old Fort Collins field, Larimer County, Colorado, a well deepened to the second sand of the Dakota group tested about 300 barrels of oil and some water daily.

Extensions to old fields included the completion of three oil and gas wells and one gas well in the Sunburst sand member of the Kootenai formation in the North Cut Bank field, Glacier and Toole counties, Montana, one well testing as much as 43 million cubic feet of gas daily. At the north end of the main oil-producing part of the Cut Bank field and downdip slightly from 3 near-by oil wells the Sunburst sand yielded the largest gas well yet discovered in Montana—80 million cubic feet per day. Southeast of the town of Cut Bank, the oil field was extended eastward about 1 mile to about its east limits, and one well extended the north limits of the oil field about ¾ mile.

At Lance Creek, Wyoming, Sundance sand oil production was extended more than one mile east in 1939 to a point slightly more than 4½ miles east northeast of the present west limits of the field. At Wilson Creek, Rio Blanco County, Colorado, Morrison sand oil production was extended slightly more than 1 mile northwest by the completion of the second oil well in the field.

Wildcatting was very much restricted throughout the region in 1939. One wildcat well is shut down near Pinedale, Sublette County, Wyoming, at a depth of 10,000 feet and another was abandoned at Divide Creek, Mesa County, Colorado, at a depth of 10,815 feet, being the deepest well yet drilled in the region. In addition, there were only 6 other really important wildcat wells completed in the region in 1939.

The only important pipeline constructed in the Rocky Mountain region in 1939 was the 438-mile line laid between Fort Laramie, Wyoming, and Salt Lake City, Utah, by the Utah Oil Refining Company.

INTRODUCTION[3]

The Rocky Mountain region in the year 1939 had no relatively important discoveries in unproved areas, but had several in old fields, as follows: (1) the finding of a widespread and rather prolific oil zone in the Minnelusa sandstone (Pennsylvanian) in the Lance Creek field,

[1] Read before the Association at Chicago, April 12, 1940, with the permission of the director of the Geological Survey. Manuscript received, March 29, 1940.

[2] Geological Survey, United States Department of the Interior.

[3] Appreciation is expressed to the petroleum engineers of the Geological Survey, United States Department of the Interior, to C. E. Shoenfelt of Petroleum Information, Inc., Denver, Colorado, and to A. E. Brainerd of the Continental Oil Company, Denver, Colorado, for many of the data contained herein.

Niobrara County, Wyoming, (2) the development of relatively prolific deeper oil zones in the Tensleep sandstone (Pennsylvanian) in the Wertz field, Carbon County, Wyoming, and (3) the discovery of oil in the second sand of the Dakota group (Upper Cretaceous) in the Fort Collins field, Larimer County, Colorado. A relatively small amount of gas was discovered on the Horne Valley anticline, Carbon County, Wyoming, minor amounts of oil and some gas were discovered in one well southwest of the Pondera field, Teton County, Montana, and substantial extensions were made to the Cut Bank and North Cut Bank fields, Montana, the Lance Creek field, Wyoming, and the Wilson Creek field, Colorado.

DISCOVERIES

WYOMING

Lance Creek field.—On May 20, 1939, the Minnelusa Oil Corporation in deepening its Joss No. 2, SE. ¼, NE. ¼, SW. ¼ of Sec. 6, T. 35 N., R. 65 W., found a zone in the Minnelusa sandstone (Pennsylvanian) at a depth of 5,260–5,307 feet that produced initially about 846 barrels of 45° Bé. gravity oil per day after acidization. For convenience this new oil-producing zone is generally called the "Joss sand" or "second bench of the Leo sand." This zone consists of porous dolomite, limestone, sandy limestone, sandy dolomite, and thin sandstones extending as much as 200 feet below the Leo sand. Several other producing wells were completed in this zone during 1939, the most distant one from the afore-mentioned Joss well No. 2 being the Continental Oil Company's Apex-1 No. 4, NW. ¼, NE. ¼, NE. ¼ of Sec. 34, T. 36 N., R. 65 W., that is, almost 4 miles northeastward. The maximum initial production of any of the four rather widely separated wells completed in this zone in 1939 was about 2,550 barrels per day.

Wertz dome.—The Wertz dome is an elliptical structure, covered by gravel and dune sand, that has produced commercial amounts of gas from the Cloverly formation (Lower Cretaceous) and the Sundance formation (Upper Jurassic) since September, 1920. Some gas was also found in the top of the Frontier formation, and one well produced about 50 barrels of oil per day from the subjacent Mowry shale—both producing zones being of Upper Cretaceous age.

At the Wertz dome in 1936, the Sinclair-Wyoming Oil Company's Government No. 10-A, center of SE. ¼, NW. ¼, Sec. 7, T. 26 N., R. 89 W., discovered about 2,000 barrels of 35° Bé. gravity brownish green oil per day in the top of the Tensleep sandstone (Pennsylvanian) at a depth of 5,869–5,883 feet. In 1939, well No. 10-A and several other

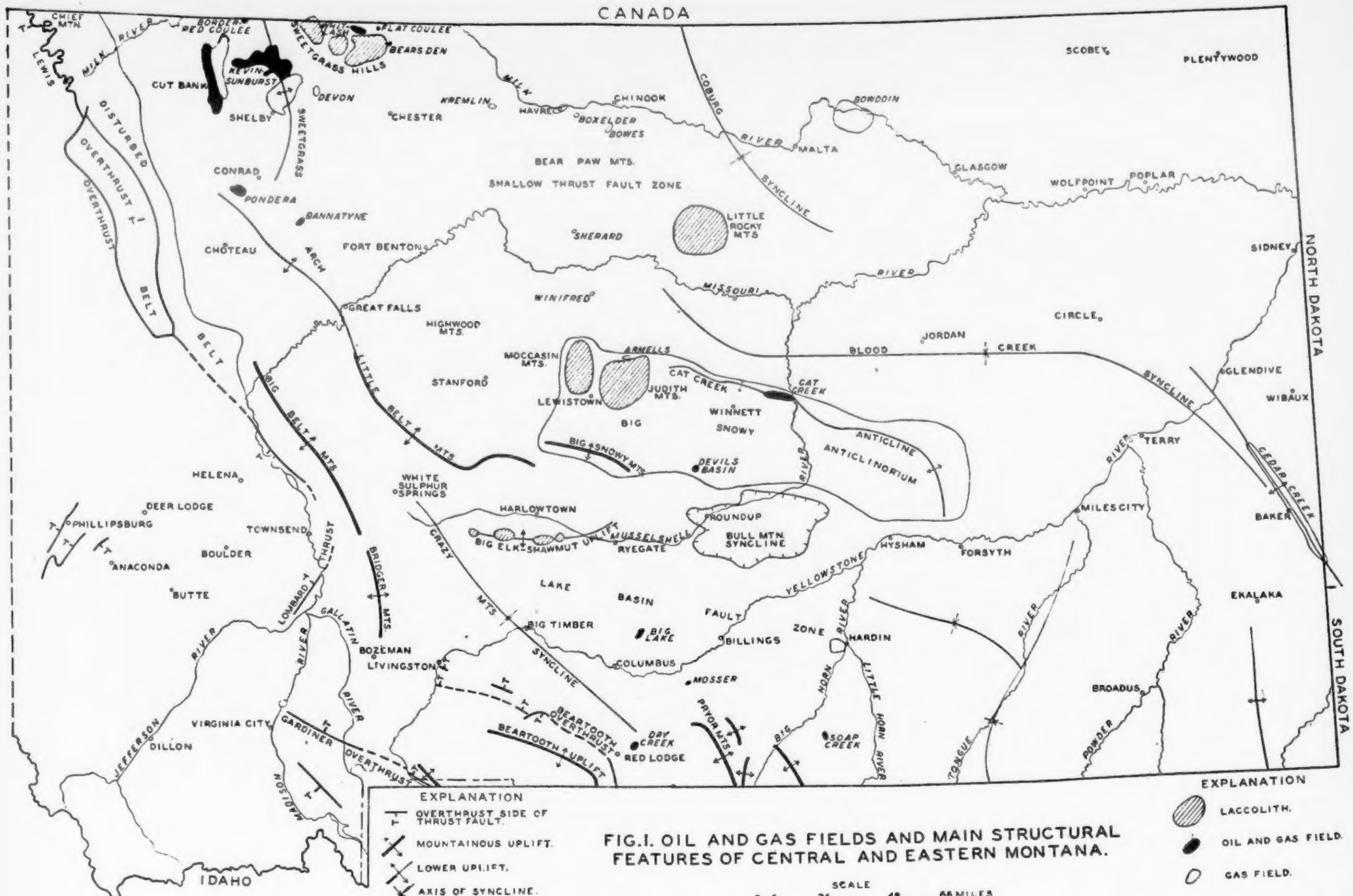


FIG. I. OIL AND GAS FIELDS AND MAIN STRUCTURAL FEATURES OF CENTRAL AND EASTERN MONTANA.

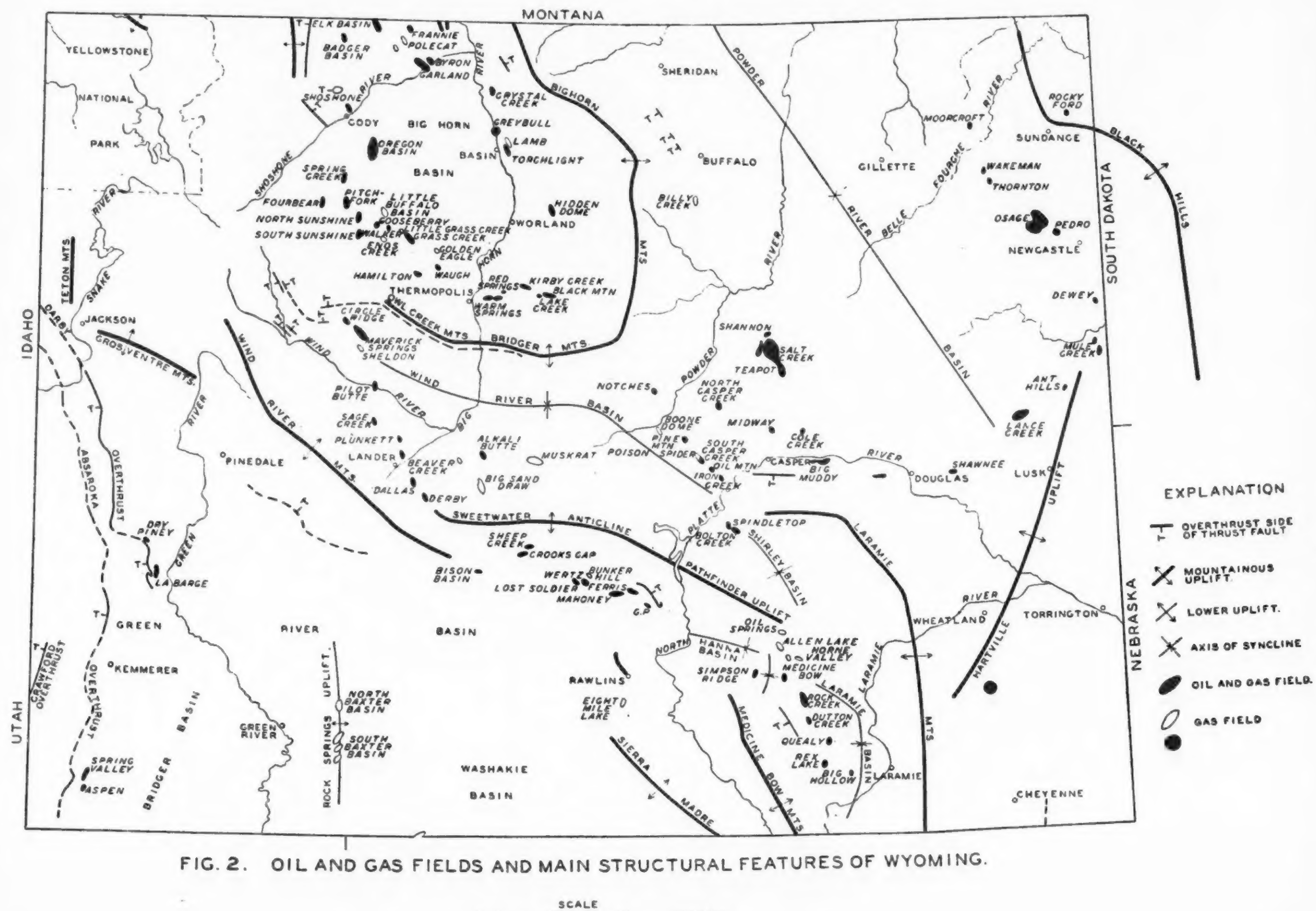


FIG. 2. OIL AND GAS FIELDS AND MAIN STRUCTURAL FEATURES OF WYOMING.

producers in the upper Tensleep were drilled deeper into that formation—278 feet for No. 10-A—and produced individually as much as 8,350 barrels of 35° Bé. gravity oil per day, establishing Wertz as a major oil field.

Horne Valley anticline.—The only discovery in unproved parts of Wyoming in 1939 was on the Horne Valley anticline, Carbon County, by Martin-Gaylord's Horne No. 1, NW. ¼, SW. ¼ of Sec. 22, T. 22 N., R. 78 W. After finding some gas in the sands of the Cloverly formation, this well was plugged back to the Muddy sand (Upper Cretaceous) at 750–805 feet and late in the year tested as much as 7 million cubic feet of gas per day. However, less than one-half mile northwestward the Cunningham Oil Company in 1938 drilled a stratigraphically deeper dry hole, abandoning it at a total depth of 1,719 feet in the Sundance formation.

MONTANA

No new oil or gas fields were discovered in Montana during the year 1939. However, Tarrant-Kirk's Hoeschen No. 1 in the center of NE. ¼, SE. ¼ of Sec. 34, T. 27 N., R. 5 W., in the southwest Pondera or Pendroy district, Teton County, produced minor amounts of 31° Bé. gravity oil from the Madison limestone (lower Mississippian) after acidization at a depth of 2,295–2,298 feet. This well was subsequently saved as a relatively small gas well in a sand in the Colorado shale (Upper Cretaceous) at a depth of 1,560–1,640 feet.

COLORADO

Fort Collins.—In October, 1939, the deepening of the Continental Oil Company's Meyer No. 1, SE. ¼, SW. ¼ of Sec. 19, T. 8 N., R. 68 W., a 14-year oil producer in the Muddy sand at depths of 4,437–4,492 feet, to the second sand in the Dakota group (Upper Cretaceous) resulted in the discovery of about 300 barrels of 31.7° Bé. oil per day and some water in the latter sand at a depth of 4,658–4,685 feet atop the structure. This is the first commercial oil production found in this sand in the Great Plains of Colorado. The well bottomed in the Lykins formation (Triassic(?) and probably Permian) at a depth of 5,206 feet after finding water in the Sundance formation at a depth of 5,063–5,202 feet.

EXTENSIONS TO OLD FIELDS

MONTANA

North Cut Bank.—The North Cut Bank field, Glacier County, was discovered in 1933 by the Yukon Oil Company-Sweeney *et al.* Jacobson No. 1, center of NW. ¼, NW. ¼ of Sec. 23, T. 37 N., R. 5 W.,

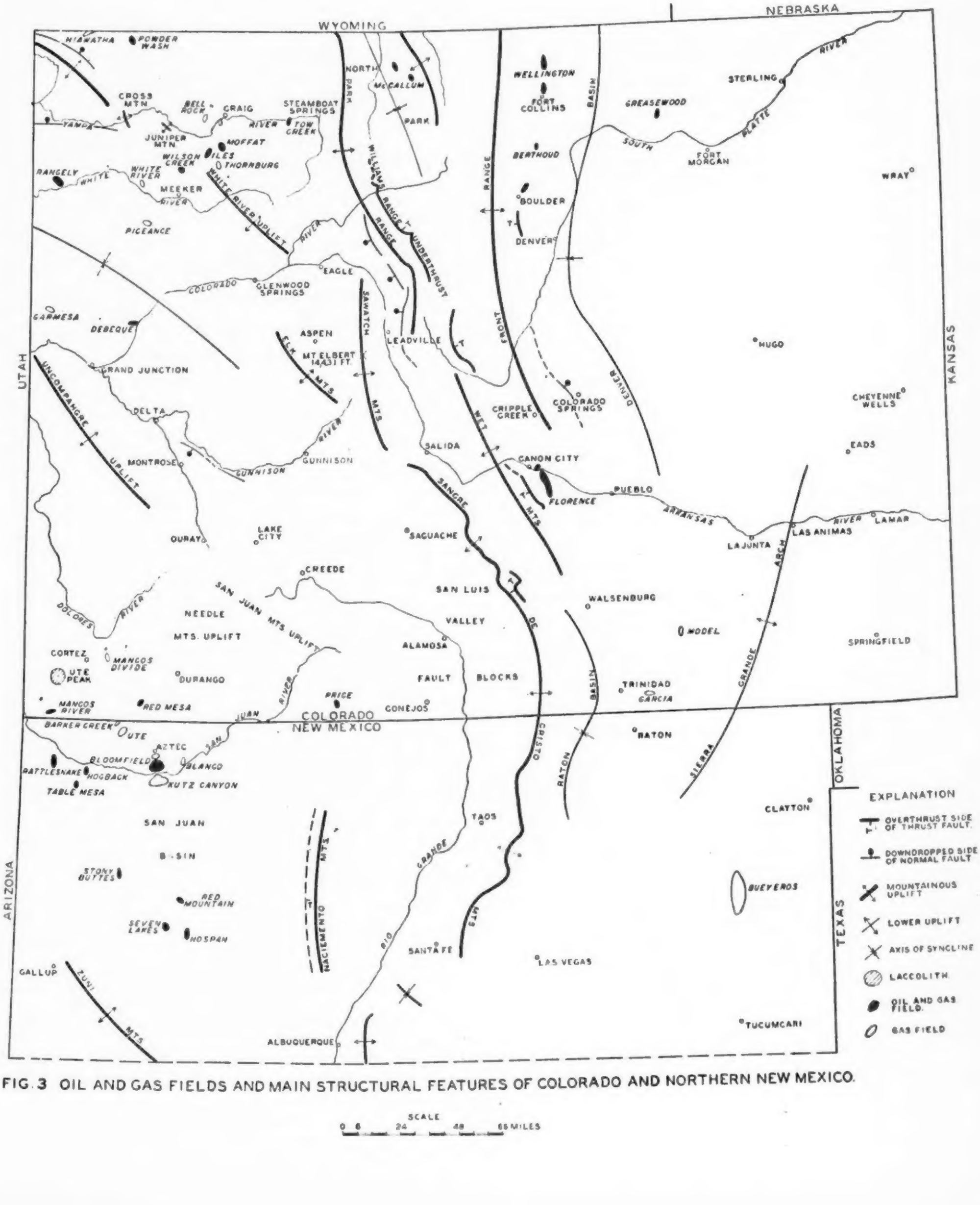


FIG. 3 OIL AND GAS FIELDS AND MAIN STRUCTURAL FEATURES OF COLORADO AND NORTHERN NEW MEXICO.

SCALE
0 8 24 48 66 MILES

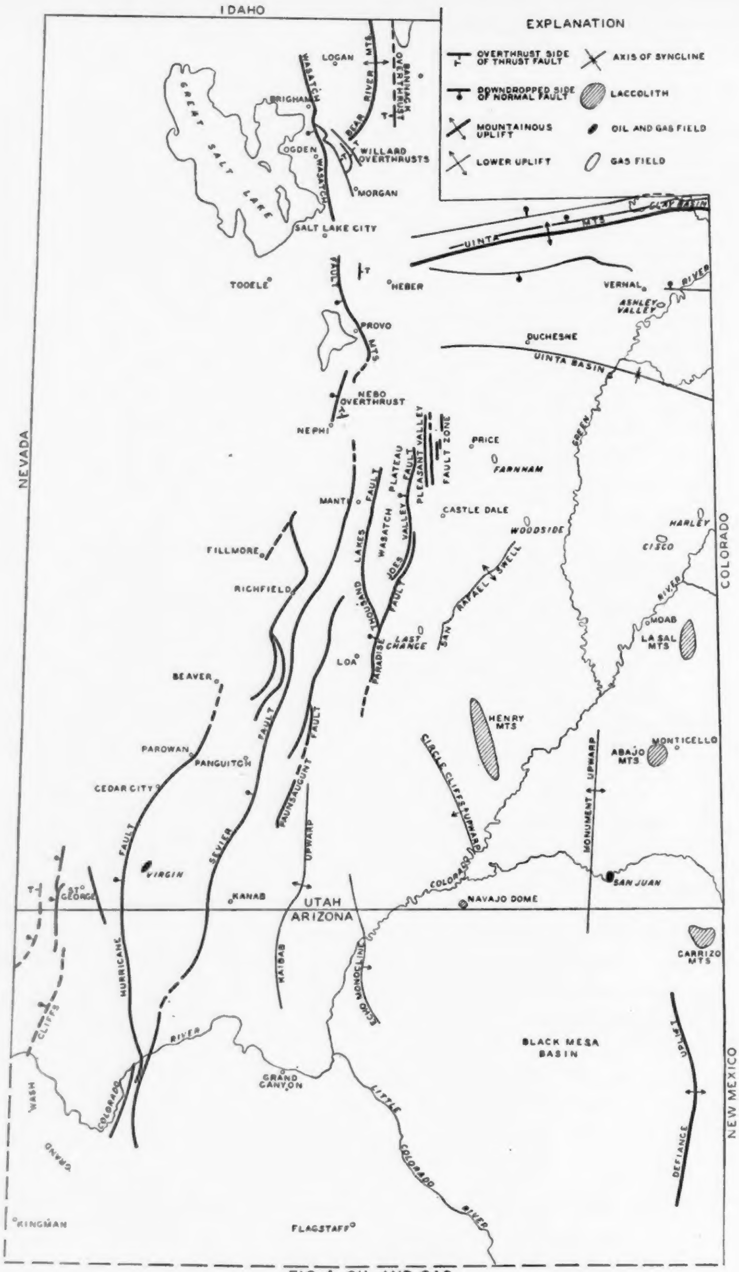


FIG. 4. OIL AND GAS
FIELDS AND MAIN STRUCTURAL FEATURES OF EASTERN UTAH AND NORTHERN ARIZONA.

SCALE
0 6 24 48 66 MILES

which had an initial production of about 69 barrels of oil per day from the Cutbank sand member of the Kootenai formation (Lower Cretaceous) at a depth of 2,619 feet. The offset to this well on the north was a dry hole drilled to the Madison limestone (lower Mississippian). The first gas well—and the first oil or gas well drilled after the discovery well—in the North Cut Bank field was A. B. Cobb's State No. 1, center of NE. ¼, NE. ¼ of Sec. 30, T. 37 N., R. 4 W., which, in 1938, discovered about 8,300,000 cubic feet of gas per day in the upper Sunburst sand member of the Kootenai at a depth of 2,572–2,585 feet and on deepening to a lower bench of the upper Sunburst at a depth of 2,597–2,606 feet gauged 40,500,000 cubic feet of gas per day.

Developments in the North Cut Bank field in 1939 were the most important in Montana that year and were carried out principally in the west half of Sec. 24, T. 37 N., R. 5 W., where three oil and gas wells and one gas well were completed.

The first well completed in 1939 in the North Cut Bank field was Chandler and Newell's Hintrager No. 1, center of NE. ¼, NW. ¼ of Sec. 24, T. 37 N., R. 5 W., which ceased drilling on May 3 at a total depth of 2,619 feet. This well had an initial production of 43 million cubic feet of gas per day, with a rock pressure of 725 pounds per square inch, from the Sunburst sand at a depth of 2,552–2,601 feet. Nadeau Brothers' Crowley No. 2, center of SW. ¼, NW. ¼ of Sec. 24, found about 2 million cubic feet of gas per day in the upper Sunburst sand at a depth of 2,560–2,573 feet and at a depth of 2,652–2,696 feet produced about 45 barrels per day of 29.7° Bé. gravity oil from the lower Sunburst sand. The Huber-Montana Corporation's Hintrager No. 2, center of NW. ¼, SW. ¼, Sec. 24, swabbed about 60 barrels of oil per day from the lower Sunburst sand at a depth of about 2,697–2,731 feet after testing 2,500,000 cubic feet of gas per day in the upper Sunburst sand at a depth of about 2,578–2,628 feet. Nadeau Brothers' Crowley No. 3, center of NW. ¼, NW. ¼ of Sec. 24 produced probably less than 100 barrels of oil per day from the upper Sunburst sand at a depth of 2,574 feet and approximately equal amounts of oil from the lower Sunburst sand at a depth of 2,662–2,723 feet. The only other well drilled in the North Cut Bank field in 1939 was A. B. Cobb's Vargo No. 1, center of SE. ¼, NE. ¼ of Sec. 19, T. 37 N., R. 4 W., which at a depth of 2,670–2,680 feet in the Sunburst sand gauged 9,650,000 cubic feet of gas per day.

Cut Bank.—At the north end of the main oil-producing part of the Cut Bank field and down dip slightly from 3 near-by oil wells, the Glacier Production Company's Rigney No. 2, center of SE. ¼, SW. ¼ of Sec. 35, T. 36 N., R. 6 W., had an estimated initial production of

80 million cubic feet of gas per day in the Sunburst sand at a depth of 2,905–2,959 feet, being the largest gas well yet found in Montana.

Southeast of the town of Cut Bank, the Cut Bank oil field was extended about 1 mile eastward to about its east limits in the center of Sec. 34, T. 33 N., R. 5 W., by the operations of the Glacier Production Company. The field was also extended $\frac{3}{4}$ mile northward by the Glacier Production Company's Larson No. 1, NW. $\frac{1}{4}$, NE. $\frac{1}{4}$ of Sec. 35, T. 36 N., R. 6 W., which, in August, swabbed 150 barrels of oil in 12 hours from the Sunburst sand at a depth of 3,022–3,028 feet.

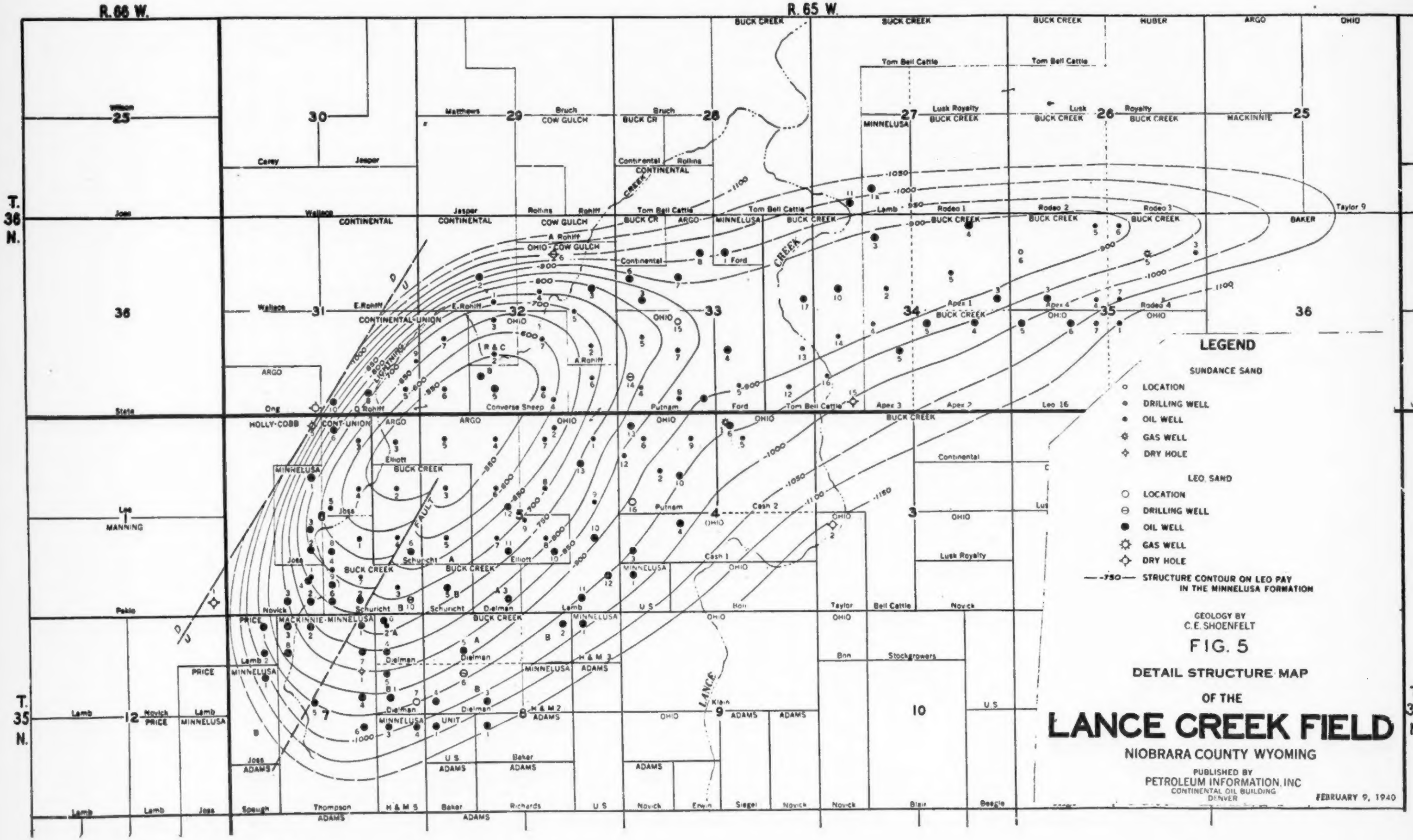
Elk Basin.—The gas-producing portion of the old Elk Basin field, Wyoming, was extended into Carbon County, Montana, by the completion in December of the Minnelusa Oil Corporation and Henderson Producing Company's No. 1-H-11, SE. $\frac{1}{4}$, NW. $\frac{1}{4}$ of Sec. 35, T. 9 S., R. 23 E., which through tubing gauged 1,500,000 cubic feet of gas per day with a spray of oil from the "Dakota" sand at a depth of 2,867–2,877 feet.

WYOMING

Lance Creek.—In 1939 oil production in the Sundance sand in the Lance Creek field was extended more than one mile eastward to the east half of Sec. 35, T. 36 N., R. 65 W., that is, slightly more than $4\frac{1}{2}$ miles east-northeast of the present western limits of the field. The easternmost Sundance wells have individual initial productions of as much as 1,005 barrels of oil per day at depths varying between 4,052 and 4,315 feet, leaving undetermined for the present the easternmost limits of Sundance production.

In attempting to extend production northwestward from the structurally highest part of the Lance Creek field, the Argo Oil Corporation's Ong No. 1, SE. $\frac{1}{4}$, SE. $\frac{1}{4}$, SW. $\frac{1}{4}$ of Sec. 31, T. 36 N., R. 65 W., drilled the top of the Spearfish formation (Triassic(?)) at a depth of 4,621 feet and encountered Upper Cretaceous marine shale at a depth of 4,786 feet. At a total depth of 5,653 feet this well was drilling Upper Cretaceous black shale dipping 70°. The offset well on the south—A. B. Cobb and Company's Novick *et al.* No. 5, NE. $\frac{1}{4}$, NE. $\frac{1}{4}$, NW. $\frac{1}{4}$ of Sec. 6, T. 35 N., R. 65 W.—drilled the top of the Spearfish formation at a depth of 4,475 feet and at a depth of 5,550 feet encountered Upper Cretaceous marine shale. The reasons for the unusual relations encountered in these two wells below the top of the Spearfish formation are as yet not fully known and will probably remain so until more subsurface data are available at distant locations.

One deep dry hole was drilled in the Lance Creek field in 1939, namely, the Continental Oil Company's Tom Bell Cattle Company No. 15, SW. $\frac{1}{4}$, SW. $\frac{1}{4}$ of Sec. 34, T. 36 N., R. 65 W., which had a total


R. 66 W.
R. 65 W.
T. 36 N.
T. 35 N.
LEGEND
SUNDANCE SAND
LOCATION
DRILLING WELL
OIL WELL
GAS WELL
DRY HOLE
LEO SAND
LOCATION
DRILLING WELL
OIL WELL
GAS WELL
DRY HOLE
-750 STRUCTURE CONTOUR ON LEO PAY IN THE MINNELUSA FORMATION
GEOLOGY BY C.E. SHOENFELT
FIG. 5
DETAIL STRUCTURE MAP
OF THE
LANCE CREEK FIELD
NIOBRARA COUNTY WYOMING
PUBLISHED BY
PETROLEUM INFORMATION, INC
CONTINENTAL OIL BUILDING
DENVER
FEBRUARY 9, 1940

depth of 5,923 feet in the Bell sand at the base of the Minnelusa sandstone.

COLORADO

Wilson Creek.—The Wilson Creek field, Rio Blanco County, was extended slightly more than one mile northwestward in 1939 by The Texas Company's Unit No. 2, NW. $\frac{1}{4}$, SE. $\frac{1}{4}$, SW. $\frac{1}{4}$ of Sec. 27, T. 3 N., R. 94 W., a joint operation with The California Company, which flowed about 365 barrels of 47° Bé. gravity oil per day at a depth of 6,525–6,624 feet. The producing zone is the same as in the discovery well, namely, a sand in the Morrison formation (Upper Jurassic).

IMPORTANT DRY HOLES

WYOMING

Pinedale.—On the Pinedale structure, Sublette County, The California Company's Unit No. 1, center of SW. $\frac{1}{4}$, NE. $\frac{1}{4}$ of Sec. 14, T. 31 N., R. 109 W., in 1939 reached a maximum drilling depth for the state—10,000 feet—bottoming, it is generally believed, in Eocene strata (probably the Evanston formation). Some gas was found in the well, but the exact amount was not determined.

North Geary.—In the last half of 1939, the North Geary dome, Natrona County, was tested to a depth of 7,320 feet by the Continental Oil Company's McGrath No. 1, center of NW. $\frac{1}{4}$, SW. $\frac{1}{4}$ of Sec. 15, T. 34 N., R. 78 W., the top of the Chugwater formation (Triassic and Permian), having been drilled at a depth of 7,012 feet. The Sundance sand—the original drilling objective—was dry, and no other zones showed encouraging amounts of oil or gas.

Ant Hills.—Oil was discovered in the small Ant Hills dome in March, 1928, when a well produced 178 barrels of oil per day from the Newcastle sandstone member of the Graneros shale (Upper Cretaceous) at a depth of 3,945–3,952 feet. The deepening in the spring of 1939 of Buck Creek Oil Company's Delahoyde No. 1, NE. $\frac{1}{4}$, NE. $\frac{1}{4}$ of Sec. 25, T. 37 N., R. 63 W., in this field to a total depth of 6,825 feet in the Pahasapa (Madison) limestone failed to reveal commercial amounts of oil or gas.

COLORADO

Divide Creek.—The Divide Creek anticline, in Mesa and Garfield counties, is about 18 miles long and has an estimated structural closure of 2,000 feet. The structure was tested in 1939 to a depth of 10,815 feet—the deepest well yet drilled in the Rocky Mountain region—by Continental Oil Company's Miller No. 1, SW. $\frac{1}{4}$, SW. $\frac{1}{4}$, NW. $\frac{1}{4}$ of Sec. 36, T. 8 S., R. 91 W., which bottomed in Mancos shale

(Upper Cretaceous). The altitude of the well mouth is 9,395 feet. Neither reliable marker beds nor encouraging shows of oil or gas were found. The abnormal thickness of Mancos shale reported suggests the presence of faulting.

Eldorado.—The Continental Oil Company's Borra No. 1, SE. ¼, NE. ¼, SW. ¼ of Sec. 5, T. 1 S., R. 69 W., Boulder County, tested the faulted Eldorado anticline in 1939 to a total depth of 6,381 feet in Pierre shale (Upper Cretaceous). The drilling objective—the Hygiene sandstone member (unrestricted) of the Pierre—yielded no promising indications of oil or gas.

SOUTH DAKOTA

Camp Crook.—The State Royalty Petroleum Company's State No. 1, center of SW. ¼, NE. ¼ of Sec. 35, T. 18 N., R. 1 E., Harding County, ceased drilling at a depth of 7,514 feet late in 1939, without reporting commercial quantities of oil or gas. No non-confidential data concerning the formations drilled in this well are available at the present writing.

PIPELINES

The only major pipeline constructed in the Rocky Mountain Region during the year 1939 was the 438-mile line laid between Fort Laramie, Wyoming, and Salt Lake City, Utah, by the Utah Oil Refining Company. This line consists of 414 miles of 8-inch pipe between Fort Laramie and Wasatch, Utah, and 24 more miles of 6-inch pipe to Salt Lake City. The line connects with older lines from the LaBarge, Rock River, Lance Creek, and Salt Creek fields of Wyoming.

TABLE OF OIL PRODUCTION*

State	*1937*	*1938*	*1939*
Colorado	1,578,391	1,324,374	1,401,199
Montana	5,799,364	4,824,917	5,854,116
New Mexico	382,687	344,637	302,550
Wyoming	19,637,218	18,956,277	21,492,187
Totals	27,397,660	25,450,205	29,050,052

* Production figures from the *Oil and Gas Journal* (January 25, 1940). Figures on New Mexico include only production from the San Juan Basin fields.

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SIGNIFICANT DEVELOPMENTS IN CALIFORNIA, 1939[1]

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ABSTRACT

Stratigraphic traps have assumed an increasingly important place in the consciousness of California geologists. All possible structures, new and old are being scrutinized or reviewed with this dominant thought in mind.

Four new oil fields were discovered in California during 1939, one of which is definitely established as a field of major proportions. In addition, five important extensions of known fields were made.

The near-future exploration in California will probably be guided largely by detailed subsurface studies in the vicinity of proved fields, although use of the reflection seismograph will continue but in lesser degree. Wildcat drilling in the state is declining as more and more thought is devoted by company managements to the financing and arrangement, under rather severe curtailment, of required development programs in recently discovered fields.

INTRODUCTION

In reviewing the history of our science, it becomes apparent that certain periods are made rich by the introduction of a new idea or by a new interpretation of an old idea in a clearer manner. It is during these periods that we "become at once heir to an industrious past and custodian of a broader future." Nevertheless, we are bound by the commercial standards of our age, and every such idea eventually must be translated in terms of new oil discoveries. Thus research and cumulative effort are justified.

About 3 years ago, we entered such a period of enriched geologic thought as a more usable conception of the stratigraphic trap and its potentialities was presented. Full advantage has not been taken in California of this new understanding of a long known condition; but within the past 2 years, the search for stratigraphic accumulation has resulted in three most significant and prolific discoveries: namely, Coles Levee and the Eocene fields at Coalinga.

NEW OIL FIELDS

During 1939, four new oil fields were discovered in California, all located in the central part of the state in the San Joaquin Valley. Only one to date has revealed the proportions of a major oil deposit. Two of the new fields (Paloma and Strand) resulted wholly from detailed seismograph work, while the remaining two (Northeast Coalinga and Southeast Mt. View) were located on the basis of geologic studies principally.

[1] Read before the Association at Chicago, April 12, 1940. Manuscript received, April 30, 1940.

[2] Research geologist, Union Oil Company of California.

NORTHEAST COALINGA

The Northeast Coalinga field (Fig. 1), discovered by the Amerada Petroleum Corporation in April, 1939, is the most outstanding one of the year. The discovery well (S.P.L. Co. No. 7-17) is located in Sec. 17, T. 19 S., R. 18 E., as shown circled in Figure 2, and is producing from 200 feet of continuous Gatchell oil sand (middle Eocene) at a total depth of 8,237 feet, still in oil sand. The initial production rate (based on a 1-hour gauge) was 4,225 barrels per day of 32.6° gravity oil, cutting 1.1 per cent, and 14,200,000 cubic feet of gas, flowing through a 44/64-inch bean with 1,850-pound tubing pressure and 1,900-pound casing pressure.

The surface geology here shows a long, southeast-plunging fold, called the Coalinga anticline, which has a definite bow on its east flank in the vicinity of this field. The zero isopach of the Gatchell sand (Fig. 2) trends roughly normal to the axis of this eastward-plunging bow, indicating the presence here of a typical stratigraphic trap (Fig. 3). The Gatchell sand is exceptionally uniform, not only from the standpoint of texture but of permeability which averages 1,500 millidarcys and which ranges as high as 6,000 millidarcys. Other prolific California fields have an average permeability of 200-450 millidarcies. Although a maximum thickness of 800 feet of Gatchell sand has been cored to date, the greatest interval of saturated sand in the field is about 450 feet (half of which is in the gas cap).

The field will probably include 1,200 acres and have an ultimate production of 100 million barrels of oil.

PALOMA

The second in importance of new fields is Paloma, discovered jointly by the Western Gulf Oil Company and The Texas Company in August, 1939, with a well (K.C.L. No. 54-3) located in Sec. 3, T. 32 S., R. 26 E. (Fig. 1). The initial production rate of the well (based on ½-hour gauge) was 2,280 barrels per day of 51° gravity oil, cutting 0.1 per cent, and 14,750,000 cubic feet of gas, flowing through a ⅜-inch bean with 3,250-pound tubing pressure and 3,400-pound casing pressure at a total depth of 10,178 feet. The producing interval of 170 feet (aggregating about 130 feet of oil sand) is part of the Stevens zone of upper Miocene age. The oil sands have a relatively low permeability, averaging under 100 millidarcys.

Although only a one-well field at the present time, it appears to have potentialities of major proportions. The field is probably related structurally to Coles Levee. A comparison of longitudinal sections (Figs. 4 and 5) at Paloma and Coles Levee indicates the extreme

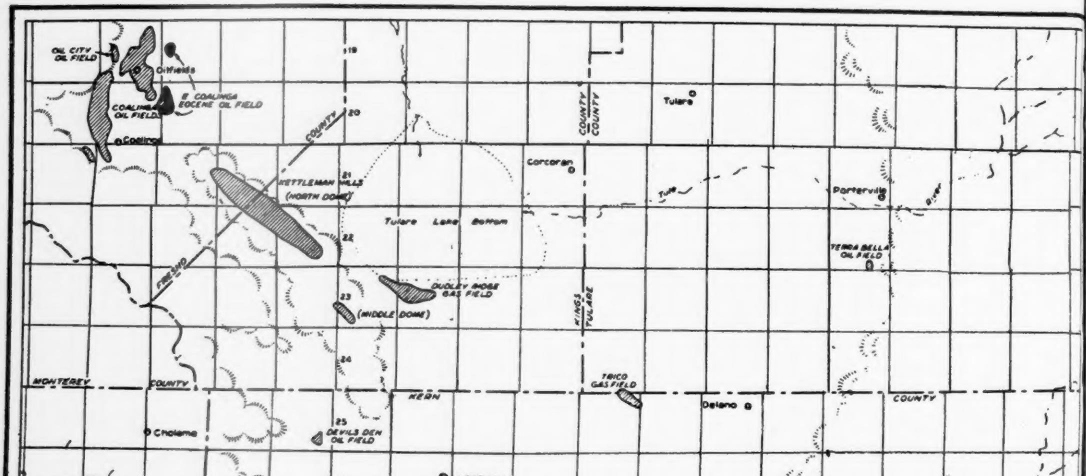

FIG. 1.—Southern San Joaquin Valley showing oil fields (after H. W. Hoots); new discoveries and extensions shown in solid black.

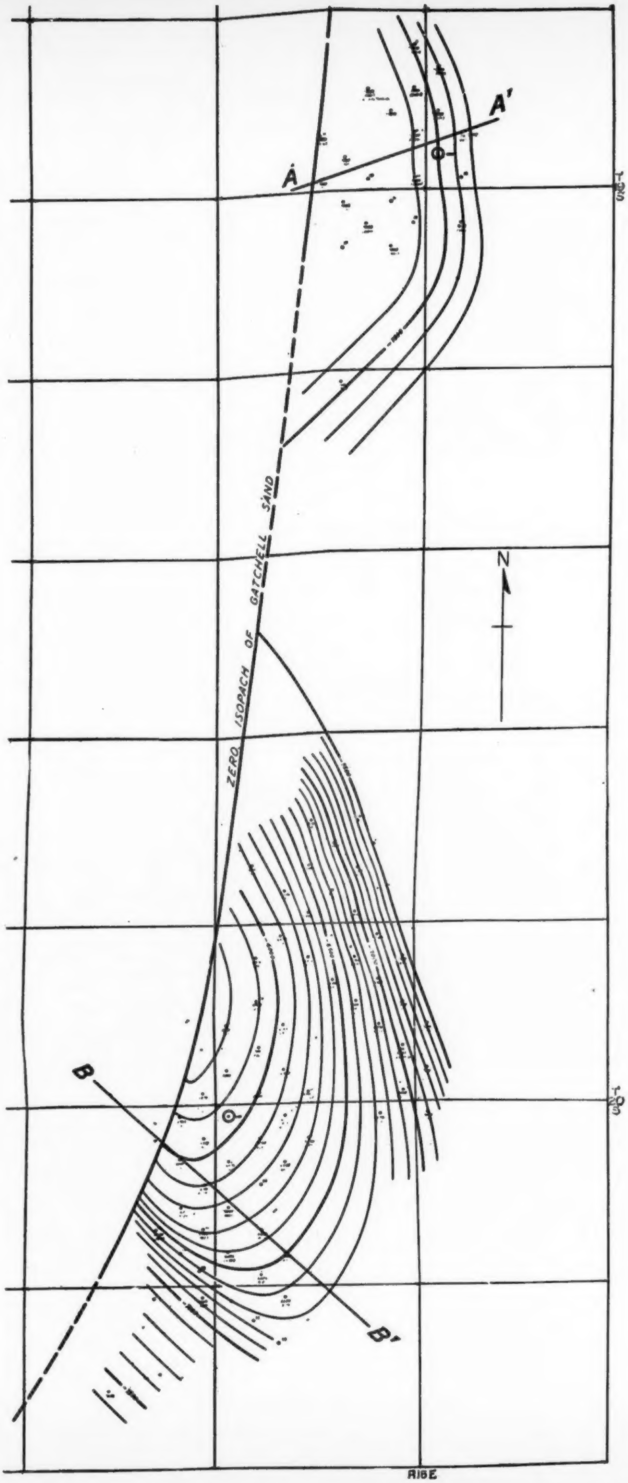

FIG. 2.— Contours on top Gatchell sand showing relationship of new Eocene fields at Coalinga. Discovery wells shown circled. Scale, 1 inch=4,575 feet.

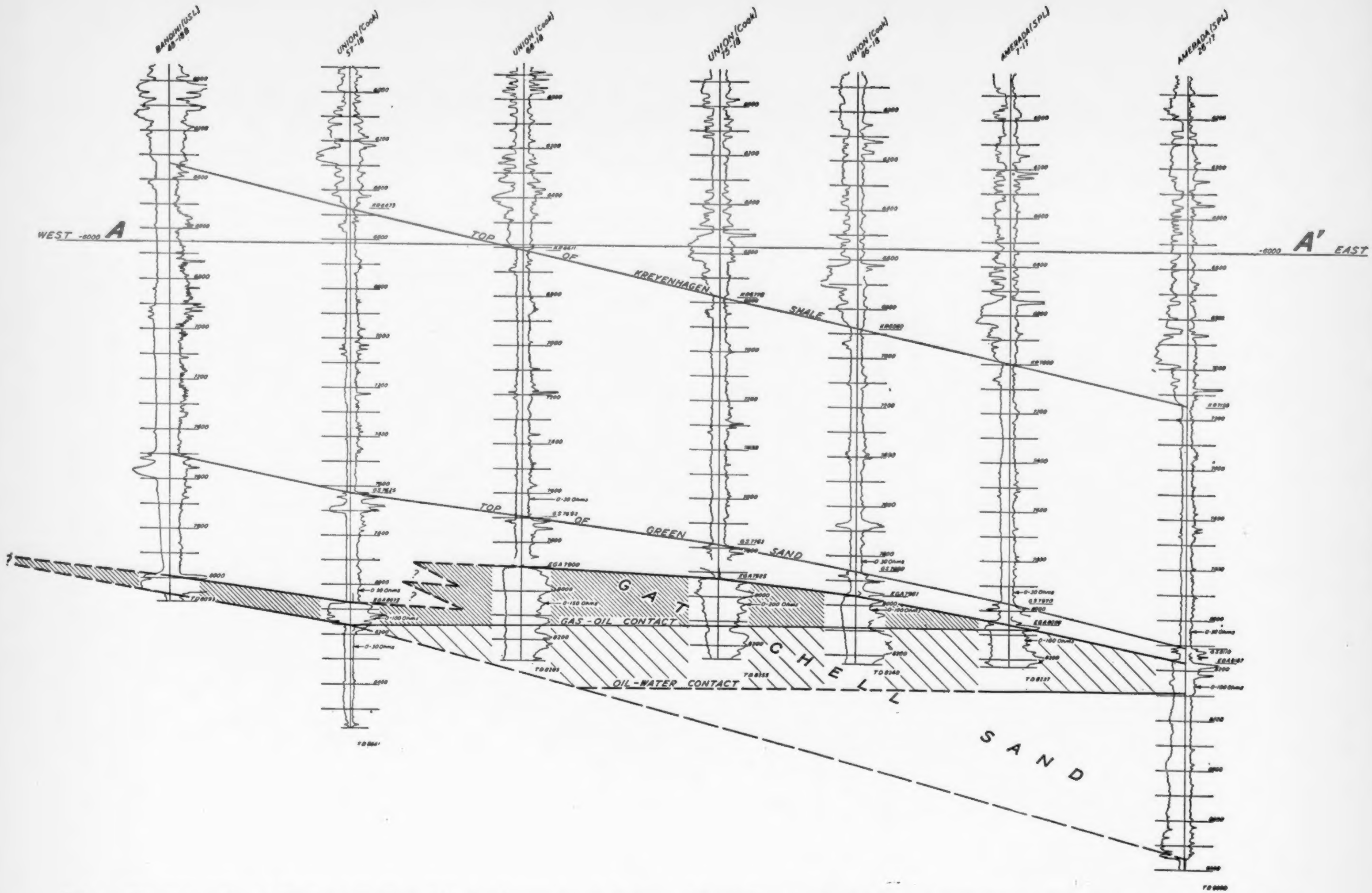

FIG. 3.—Structure section at Northeast Coalinga field, showing westward pinch-out of Gatchell sand and relationship between gas, oil and water. Scale, 1 inch=600 feet.

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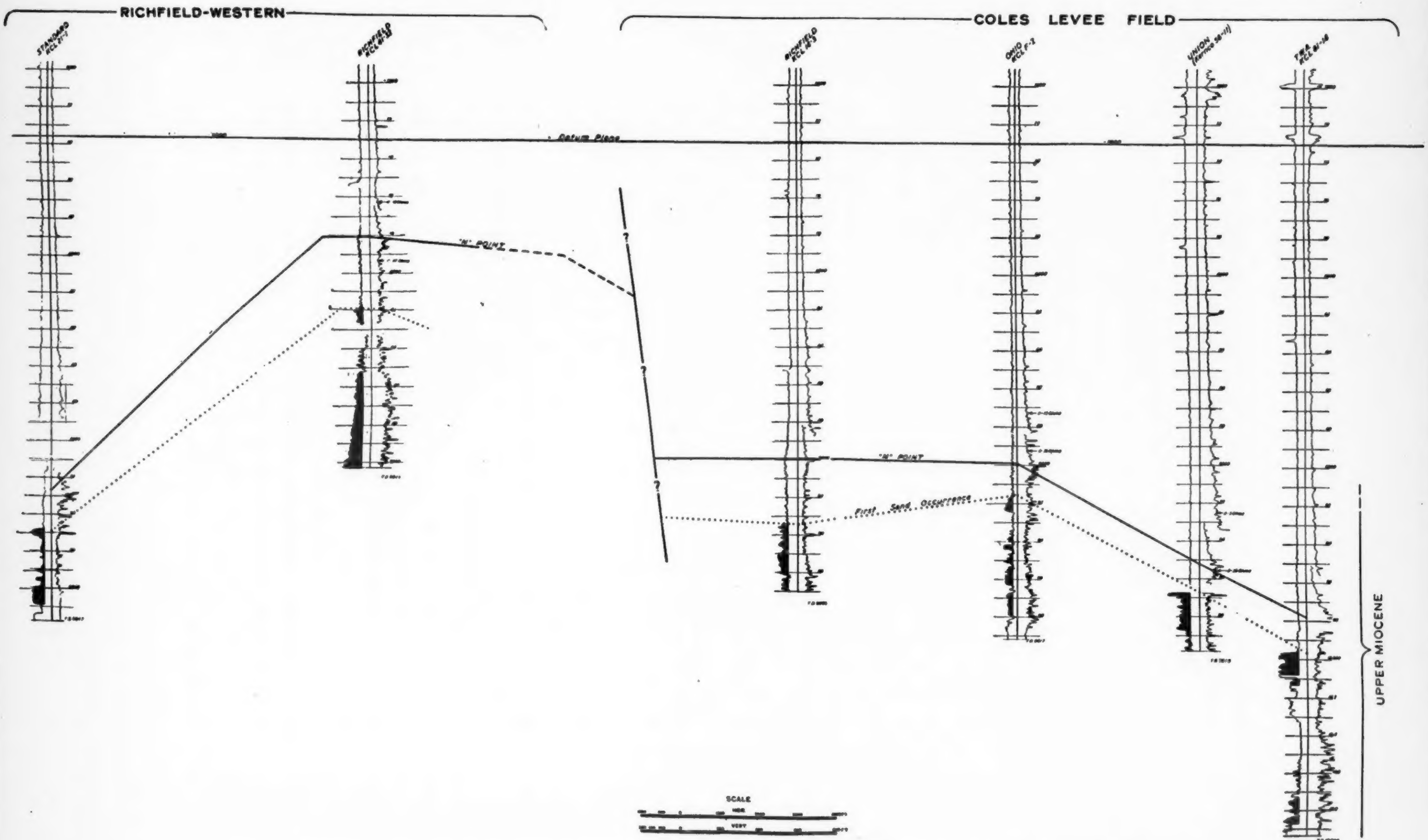

FIG. 4.—Structure section trending northwest through Coles Levee field. Portions of electrical log shown in solid black indicate oil sands. Horizontal scale, 1 inch = 4,000 feet. Vertical scale, 1 inch = 800 feet.

variability of the sand members in the Stevens zone. The first oil sand is not everywhere continuous, as is shown by the varying depth of its occurrence below a stratigraphic marker ("N" point, correlated with solid line). Adequate evidence is still lacking, but it would appear that accumulation results from anticlinal control, plus probable faulting.

STRAND

The Tide Water Associated Oil Company discovered Strand in June, 1939, with a well (K.C.L.-E No. 35-7) located in Sec. 7, T. 30 S., R. 26 E. The initial production was 1,306 barrels per day of 34° gravity oil, cutting 3.3 per cent, and 978,000 cubic feet of gas, flowing through a 48/64-inch bean with 100-pound tubing pressure and 800-pound casing pressure from a total depth of 8,364 feet (plugged to 8,320 feet). The wells in the field produce from a 35-foot sand in the upper part of the Stevens zone.

The structure is a small, flat anticline, embracing approximately 300 acres, and might produce ultimately 10 million barrels from the sands known at present.

SOUTHEAST MT. VIEW

The Union Oil Company drilled a well at Southeast Mt. View in 1938 and cored oil sands of commercial importance. Although the production test was unsuccessful, the well suggested the oil possibilities of the area, and it remained for the Universal Consolidated Oil Company to make a discovery the following year in a near-by well. The initial yield (calculated from a short flow of $1\frac{1}{2}$ hours) was 3,800 barrels per day of 29.6° gravity oil, cutting 1 per cent, and 5 million cubic feet of gas, flowing through two $1\frac{1}{2}$-inch beans. The total depth is 6,173 feet and the oil-bearing sands (aggregating 75 feet through an interval of 275 feet) are in a non-marine series (middle Pliocene) with interbedded marine fingers.

The field occurs in a fault intersection and is a duplication on a smaller scale of similar accumulations along a major northwest-trending fault. Probably less than 200 acres will be included in the field and its ultimate production may not exceed 2 million barrels of oil.

EXTENSIONS OF KNOWN FIELDS

Included in this division are the areal extensions of recently discovered fields, together with new productive zones in older fields.

COLES LEVEE

Although in 1938, credit was given to both the Ohio Oil Company

and the Richfield Oil Corporation for separate discoveries at Coles Levee and Richfield-Western, respectively, later development suggests that these two producing areas more properly should be considered as belonging to one field. For this reason, the name "Richfield-Western" is now used only to designate an area and not a field.

Stratigraphy is still thought to be a contributing factor in accumulation here, but more and more evidence is being assembled to indicate that folding and faulting exercise the greatest control. Very rapid expansion of this field has taken place during 1939. Approximately 3,800 acres have been proved by 23 producing wells and 3 dry holes. A possible ultimate yield for the field is now placed at 75 million barrels of oil.

GREELEY

The discovery in June, 1938, by the Standard Oil Company of commercial production from the deep Vedder sand (lower Miocene) in the small Greeley field (Fig. 1) was most significant. It failed, however, to initiate much new drilling. Not until the General Petroleum Corporation completed its Sullivan No. 1 at a total depth of 11,510 feet in November, 1939, did development work accelerate. This well had an initial rate yield (based on a gauge of $20\frac{1}{3}$ hours) of 1,469 barrels per day of 39.3° gravity oil, cutting 3.0 per cent and 1,850,000 cubic feet of gas, flowing through a 24/64-inch bean with 1,660-pound tubing pressure and 1,700-pound casing pressure. The producing interval includes both the Rio Bravo and Vedder sands from 11,327 feet to 11,510 feet. The structure is a narrow, closed anticline 4 miles long and 1 mile wide, including probably three small domes arranged *en échelon.*

The Sullivan well extended the field northwest about $1\frac{1}{2}$ miles, and increased the total amount of proved land to 1,800 acres. An ultimate production of 65 million barrels is indicated for this acreage.

MONTEBELLO

In April, 1939, the Union Oil Company completed its La Merced No. 30 as the discovery of a new lower zone, called the "Eighth zone" (upper Miocene), at West Montebello (Fig. 6). The initial production was 710 barrels per day of 35.3° gravity oil, flowing. Although drilled to a total depth of 8,468 feet, the hole was plugged back and is producing from a 79-foot interval between 7,551 feet and 7,630 feet.

The well is located on the east plunge of the West Montebello anticline, as shown circled in Figure 7. It extended the field about $\frac{1}{2}$ mile eastward and added another "layer to the cake." Approxi-

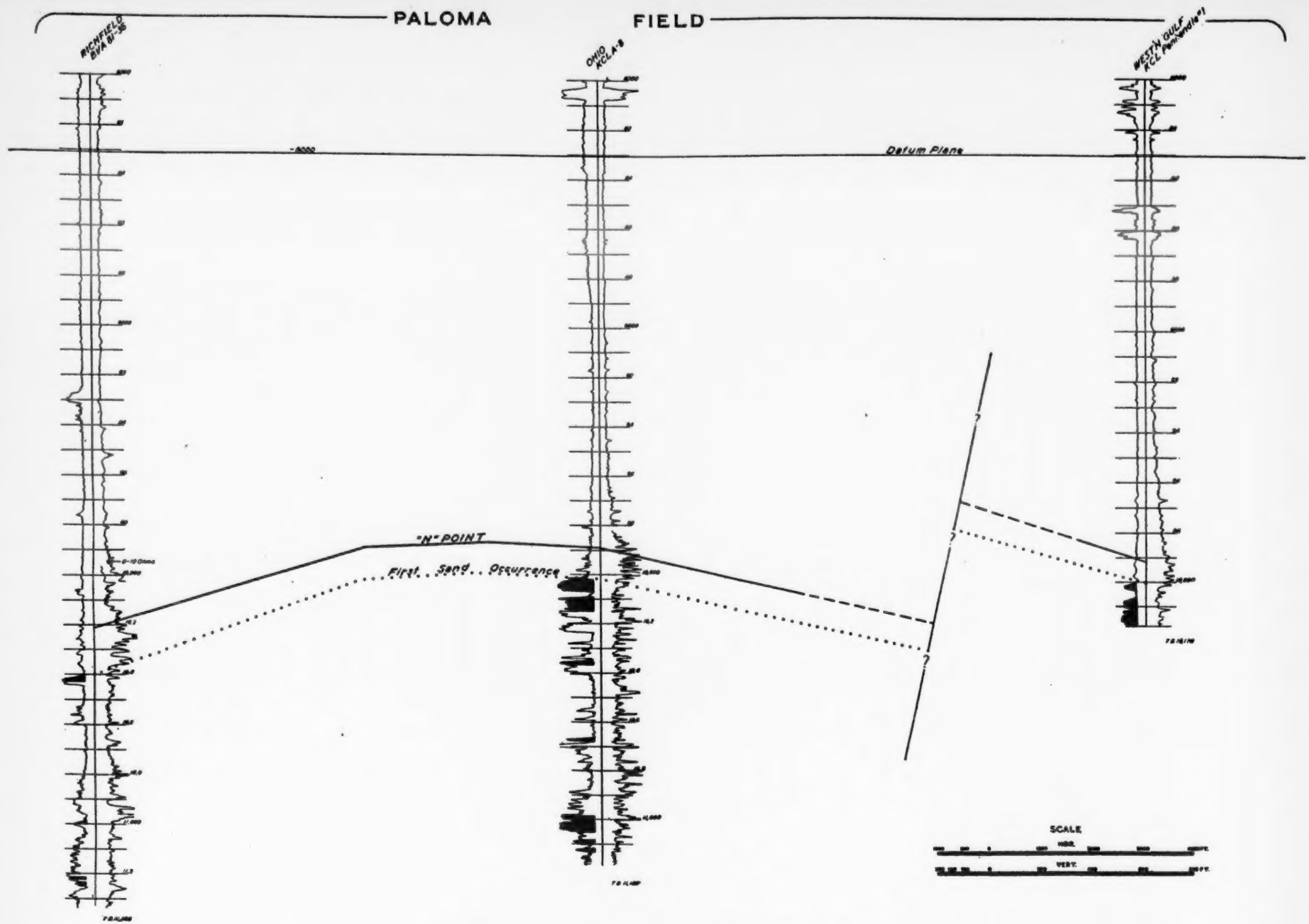

FIG. 5.—Structure section trending northwest (roughly longitudinal) through Paloma field. Portions of electrical logs shown in solid black indicate oil sands.

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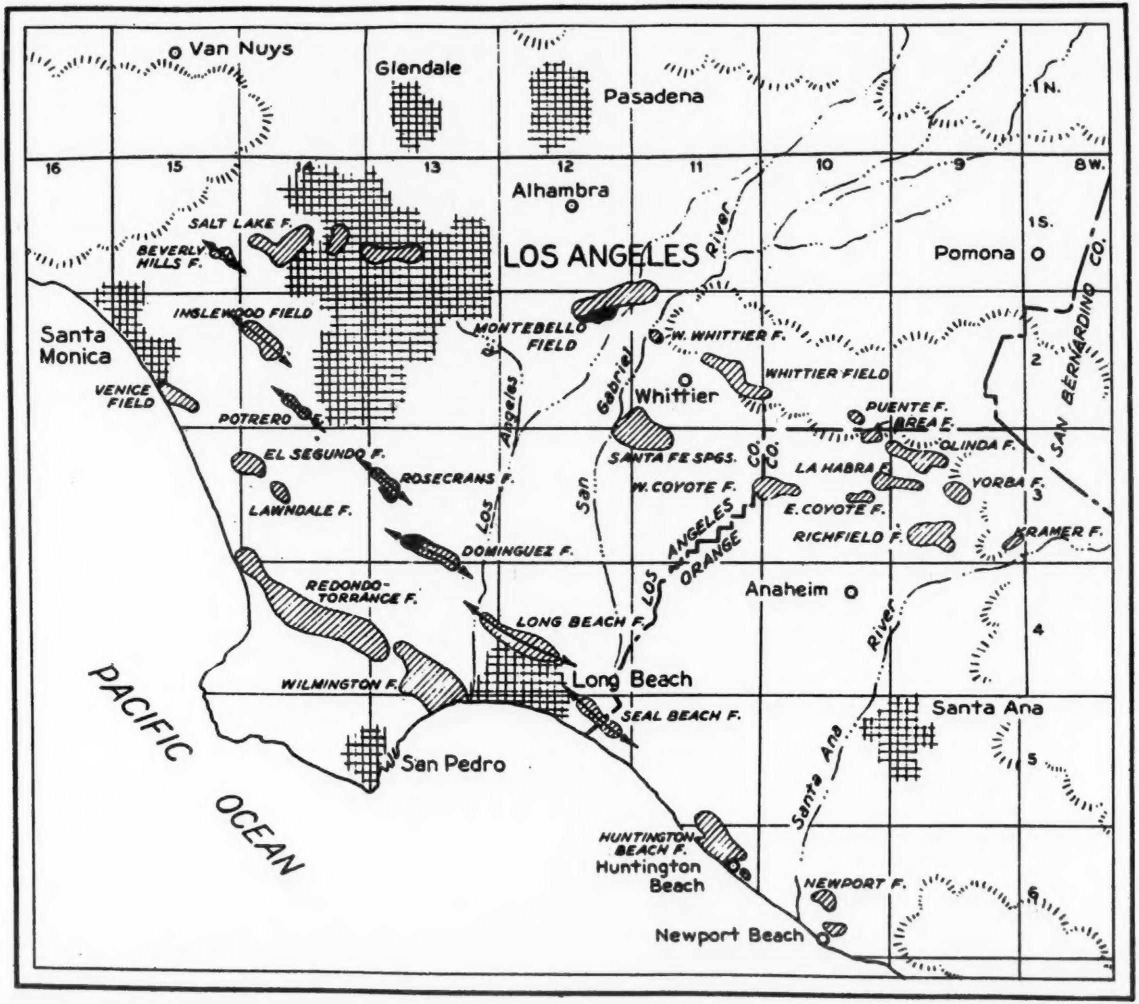

FIG. 6.—Los Angeles Basin fields (after H. W. Hoots) with extensions of productive limits shown in solid black.

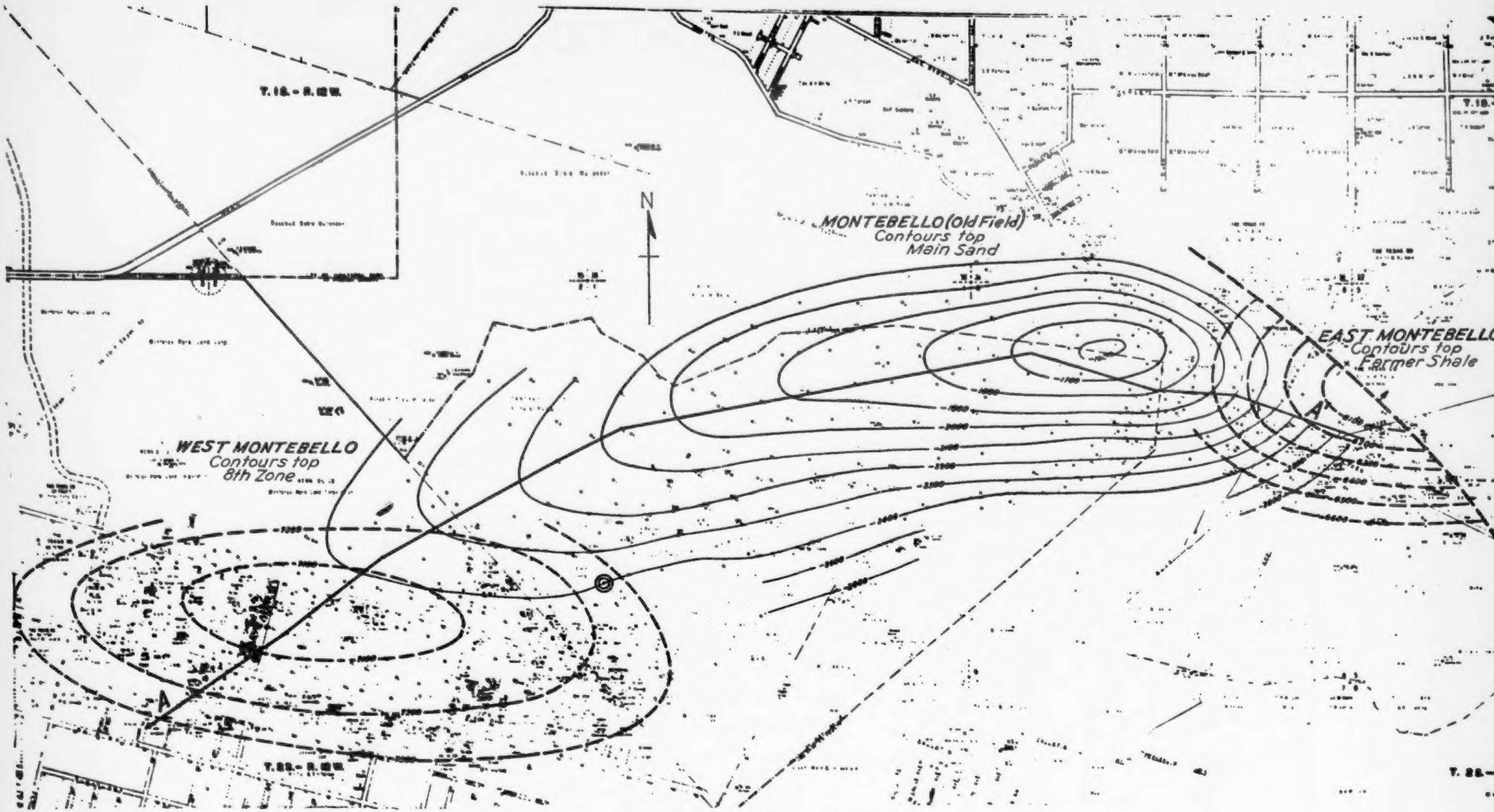

FIG. 7.—Structure contours at Montebello field showing relative positions of productive features. Discovery well (Union Oil Company's La Merced No. 30) of Eighth zone at West Montebello shown circled. Scale, 1 inch = 2,250 feet.

mately 600 acres are proved here and an ultimate production of at least 15 million barrels is indicated.

The more complete development of West Montebello during 1939 has revealed an interesting structural relationship between this field and the adjacent producing areas. The original Montebello field, or so-called "Old field," is an elongate Pliocene dome superimposed over a saddle between the two lower "highs" of East and West Montebello (Fig. 7). These latter extend downward into the Miocene as accumulation provinces while the former is confined entirely to the Pliocene. The gradual increase in thickness of younger sediments (Fig. 8) over the saddle may be apparent in part and result from steeper dips at depth on the north flank of the Pliocene dome, but it is in larger part the result of more material having been deposited.

One possible explanation of this phenomenon is that the overlying symmetrical Pliocene fold derives its present structural identity largely from differential compaction or downwarping. The closure over the buried sand lens decreases upward, which is typical of such structures; and the arrangement of the original clays or muds around the lens has permitted greater compaction on the flanks than over the crest.

DOMINGUEZ

The productive Miocene province at Dominguez was extended westward almost ½ mile by the completion of R. E. Havenstrite-Larronde No. 1. The well, originally drilled to 7,543 feet, was plugged back to 7,500 feet, and is producing from the seventh and eighth zones between 6,974 feet and bottom. The initial production was 906 barrels per day of 31.0° gravity oil, cutting 12 per cent, and approximately 900,000 cubic feet of gas, flowing through a 24/64 inch bean with 400-pound tubing pressure and 1,300-pound casing pressure.

Accumulation in the Miocene here is governed mainly by a complex series of both thrust and normal faults. Although the Dominguez anticline provides closure in the Pliocene, its effectiveness as an independent trapping agency in the Miocene appears to have been destroyed in some manner.

ROSECRANS

Structural conditions here are quite similar to those at Dominguez. Miocene accumulation is dependent almost entirely upon fault control. The rather meager yield of an outpost well drilled by Howard Oil Associates and completed in August, 1939, for approximately 100 barrels per day of 32.7° gravity oil suggested that another fault trap extension had been discovered. This was confirmed later by the

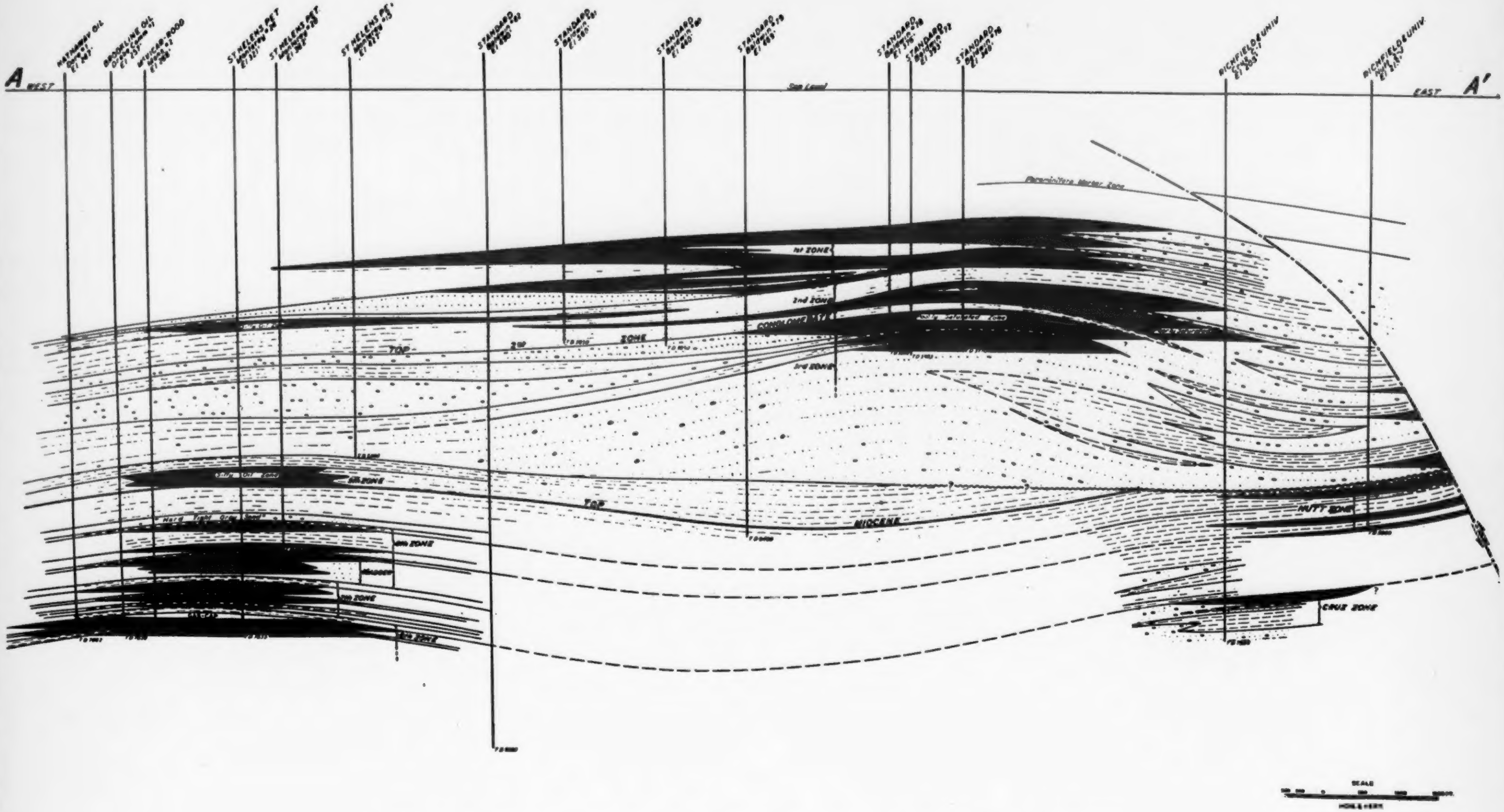

FIG. 8.—Structure section at Montebello field showing buried sand lens beneath "Old field."

completion in October, 1939, of Slabaugh No. 1 by the Southern California Petroleum Company at a total depth of 7,636 feet for about 200 barrels per day. A month after completion, the well built up to 950 barrels per day of 32.4° gravity oil, cutting 0.6 per cent and 1,025,000 cubic feet of gas, flowing through a 28/64-inch bean with 420-pound tubing pressure and 1,250-pound casing pressure. These wells have extended the field southeast more than ½ mile.

OTHER FIELDS

Orderly, routine development in other San Joaquin Valley fields, as Rio Bravo, Canal, Ten Sections, and especially Southeast Coalinga, Eocene (Fig. 1), has provided extensions of varying degree. The proved land in the last named field has been increased to about 2,500 acres with an ultimate yield indicated of more than 275 million barrels.

EXPLORATORY WORK

Fewer wildcat wells were drilled in 1939 than in preceding recent years and many of these were located on doubtful geological prospects, indicating that the odds against new discoveries were greatly increased.

Inasmuch as the areas in which the reflection seismograph can be used effectively have been greatly reduced by previous mapping, its present application is declining. Nevertheless, it is still a very important aid in exploratory work, and new technological refinements may further expand its usefulness. More and more, however, exploration is being guided by detailed subsurface studies in the vicinity of proved fields.

Production problems in California are of course duplicated in many other oil-producing states. A present abundance of crude oil, or rather a present capacity for over-production, has imposed a rather severe curtailment upon hundreds of new wells, many of which are costly. The management of every producing company must devote, therefore, increasing thought to the financing and arrangement of required development in the more recently discovered fields. The acquisition of new reserves is still very much desired, but the following obligatory drilling programs are regarded with misgivings. The situation presents a problem in investment balance and an early attempt at its solution may well result in some form of drilling moratorium; but the final and complete solution will probably await the equalizing effect of the law of supply and demand.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 24, NO. 6 (JUNE, 1940), PP. 1126-1127

GEOLOGICAL NOTES

TODD RANCH DISCOVERY, CROCKETT COUNTY, TEXAS[1]

D. D. CHRISTNER[2]
Fort Worth, Texas

A new oil field, producing from lower Pennsylvanian limestone, was recently discovered in West Texas on the Todd Ranch in Crockett County. The field is on the Edwards plateau at the southeast edge of the West Texas-New Mexico Permian Salt basin. The specific location of the well is in the center of NE. $\frac{1}{4}$, SW. $\frac{1}{4}$, Sec. 29, Block WX, GC & SF Survey.

The discovery well, the Continental-Stanolind *et al.* Todd Unit No. 2, was completed, April 3, 1940. Its initial production test yielded 840 barrels of 40.6° gravity oil in $12\frac{1}{2}$ hours, flowing through 2-inch tubing and an 11/16-inch choke. Gas flow was at the rate of 1,150,000 cubic feet a day.

Production was found in the Crinoidal limestone, which is the basal Pennsylvanian limestone immediately above the Ordovician in the Big Lake oil field, Reagan County, 30 miles north of the Todd discovery. This formation has been tentatively correlated as Strawn in age. It has produced gas, gas distillate, and oil in many of the deep wells in the Big Lake field.

This well is the second deep test to be drilled on the present unit block, and the fourth drilled in the search for Ordovician production in the immediate vicinity. In fact the discovery may truthfully be said to have been made as the result of structure drilling to the Ellenburger limestone (Ordovician).

The first of the deep tests, known as Stanolind's Todd Unit No. 1, was located in Sec. 67, Block UV. It was drilled in 1932, to a total depth of 8,041 feet in Ellenburger limestone. It appeared to be regionally high, and oil showings were reported in the basal Pennsylvanian and the Ellenburger, but no commercial production resulted.

In 1937, the Superior Oil Company drilled a deep test in Sec. 55, Block UV, on the Massie Ranch, east and south of the Stanolind test. This well encountered the Ellenburger 300 feet lower than in the initial test and found it contained sulphur water. It was abandoned at a depth of 7,948 feet.

[1] Manuscript received, May 9, 1940.

[2] Division geologist, Continental Oil Company.

Subsequently a new unit was found and the Continental-Stanolind's Todd Unit No. 1 was drilled in Sec. 30, Block WX, west of the original deep test. While this well was not a producer, and was abandoned early in January, 1940, it confirmed the presence of a pronounced local uplift in the older rocks by finding the Ellenburger 837 feet higher than it was found in the Stanolind well.

The discovery well, located approximately ½ mile farther west and north, found a further structural rise of 318 feet on the top of the Crinoidal (basal Pennsylvanian) limestone. Evidence of saturation through that limestone led to a decision to run casing and test it before drilling into the Ellenburger. The discovery resulted.

The geologic section penetrated is as follows.

Depth in Feet	
0– 365	Cretaceous: limestone, sand at base
–1,180	Upper Permian: (Whitehorse) redbeds, streaks of anhydrite and dolomite
–1,990	Permian: (upper San Andres) dolomite
–5,590	Lower Permian and possibly some upper Pennsylvanian: shale with streaks of limestone and sandy zones
–5,690	Lower Pennsylvanian: Crinoidal limestone
–5,691	Ordovician: (Simpson) green shale with limestone and imbedded rounded sand grains

It has considerable potential importance beyond the immediate discovery, since the presence of oil in the lower Pennsylvanian and the amount of structural relief disclosed are generally regarded as presaging the finding of another Ordovician field in West Texas.

Interest in the area was first aroused in 1925 by the mapping of a closed anticline in the Cretaceous rocks. Several Permian limestone tests were subsequently drilled and some production of negligible importance was obtained.

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DISCUSSION

ARE THE "OMPHALOTROCHUS BEDS" OF THE U.S.S.R. PERMIAN?[1]

J. BROOKES KNIGHT[2] *ET AL.*
Princeton, New Jersey

Dunbar's recent summary of his understanding of the Permian stratigraphy and correlations of the type area in Russia[3] is so lucid that many English-speaking geologists are now able, for the first time, to get a clear, if simplified, general picture of the regional sequences and a rational series of regional and worldwide correlations. Some of the correlations suggested are put forth with considerable assurance; others are tentative. Among the beds on which the evidence is considerably less than conclusive are the *Omphalotrochus* beds (C $\frac{1}{3}$) of the Moscow basin,[4] and the *Omphalotrochus* (C $\frac{1}{3}$) and the *Cora* beds (C $\frac{2}{3}$) of the Timan arch. Dunbar places these beds in the upper Carboniferous zone of *Triticites*, seemingly because they fall in the section below the beds identified by the Russians as the "*Schwagerina* horizon" (C $\frac{3}{3}$), Dunbar's zone of *Pseudoschwagerina*. No fusulinids or other fossils, except, by implication, those which give their names to the beds, are cited in evidence from the regions in question. True, the *Omphalotrochus* and *Cora* beds are correlated with the *Triticites* beds of the Samara bend and at the Sim Works for which the evidence for upper Carboniferous age seems to be fairly compelling. But the evidence for these intra-regional correlations seems to be hardly more than that stated; namely, that the beds in question in all four areas are found below beds from which *Pseudoschwagerina* has been reported.

My own field of research is Paleozoic gastropods, and there is one very important genus of gastropods that comes into the picture, the genus *Omphalotrochus* Meek. Unless an earlier appearance in Russia forms an exception, the genus *Omphalotrochus* makes its first appearance throughout the world at the base of what appear to be the equivalents of the Wolfcamp series in the southwestern United States.

The genus *Omphalotrochus* has been greatly misunderstood, principally because it was confused with other very different genera in the Zittel-Eastman *Textbook of Palaeontology*, which has been widely followed by other textbooks. Part of the confusion arose because Meek, when he established the genus, seems to have been led by poorly preserved specimens of the genotype species to misinterpret what is probably the most distinctive character of the genus, the outer lip. Nevertheless, certain paleontologists have successfully recognized the genus, even from the confused literature. Thanks to the cour-

[1] Manuscript received, April 10, 1940.

[2] Department of geology, Princeton University.

[3] Carl O. Dunbar, "The Type Permian: Its Classification and Correlation," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 2 (February, 1940), pp. 237–81.

[4] *Ibid.*, p. 249.

tesy of Professor Dunbar, who loaned me a copy of a very recent Russian publication on Carboniferous guide fossils,[5] I have been able to confirm that the Russian paleontologists have correctly identified the genus. Their most abundant and widespread form, *O. whitneyi rossicus* Licharew, is actually so nearly identical with *O. whitneyi* Meek, the genotype from the McCloud formation of California, that I would find it difficult to justify the subspecific name that Licharew has given it.

Licharew, in the recent work cited[6], figures *O. whitneyi rossicus* from the *Omphalotrochus* beds of the Timan arch. He lists it from the *Pseudoschwagerina* beds of the Timan arch, and from the *Omphalotrochus* beds of the Moscow basin and the Don basin, and from the Juresan (*Pseudoschwagerina* beds) of the Ufa plateau. Thus we have in Russia in the "*Omphalotrochus* beds" not only a genus that occurs in no other region, so far as known, below the Wolfcamp equivalents (zone of *Pseudoschwagerina* and of *Properrinites*), but a species that is common to both the *Omphalotrochus* beds and the locally designated *Pseudoschwagerina* beds. This suggests that *Omphalotrochus* beds of the Timan arch should be included with the *Pseudoschwagerina* beds, and that they, together with the intervening *Cora* beds, are the Russian equivalents of the American Wolfcamp series. It follows that these beds probably will be found to be younger than any beds, such as the *Triticites* beds of the Sammara bend, that seem to be the correlatives of the American late Pennsylvanian and younger than the beds of some other areas that have been referred to the stages C $\frac{1}{3}$, C $\frac{2}{3}$, and C $\frac{3}{3}$.

The suggestion made on the basis of one genus of gastropods decidedly needs confirmation, and it finds some measure of confirmation in the fact that the brachiopod genus *Waagenoconcha*, like *Omphalotrochus* unknown in other regions below the Wolfcamp equivalents, seems also to be found in the *Omphalotrochus* and *Cora* beds, as well as the *Pseudoschwagerina* beds, of the Timan arch and of the Urals. I quote the following from Tschernyschew.[7]

> Auf dem Ural ist *Pr. irginae* im *Cora*- und im *Schwagerinen*-Horizonte gefunden worden. Auf dem Timan taucht er schon im *Omphalotrochus*-Horizonte auf, erlangt aber besonders reiche Fulle im *Cora*- und in *Schwagerinen*-Horizonte.

Any modern student of the brachiopoda will at once recognize in *Pr. irginae*, as identified and figured by Tschernyschew, a typical example of the genus *Waagenoconcha* Chao.

It is contended that Tschernyschew made grave stratigraphical errors in his description of the section in the Urals, and that the beds that he there correlated with the lower part of the section in the Timan arch are actually much higher in the section. But, as far as I am aware, his description of the section in the Timan arch is still accepted, and at least that part of his statement that refers to the beds in that region still holds good. Hence in this region, at least, we find a species of the genus *Waagenoconcha* common to the

[5] *The Atlas of the Leading Forms of the Fossil Faunas of the U.S.S.R.:* Vol. V, *Middle and Upper Carboniferous*, edited by I. Gorsky with contributions by V. Webber, I. Gorsky, L. Librovitch, B. Licharew, A. Nikiforova, V. Ružencev, A. Fraas, V. Fomitchev, T. Tschernyschew, A. Khabakov, and N. Yakovlew. 179 pp., 37 text figs., 36 pls. Central Geological and Prospecting Institute, Leningrad (1939).

[6] B. Licharew, *ibid.*, p. 129.

[7] T. Tschernyschew, "Die Obercarbonischen Brachiopoden des Ural und des Timan, *Mémoires Comité Géologique* (Russia), Vol. 16, No. 2 (1902), p. 619.

Omphalotrochus, the *Cora*, and the *Pseudoschwagerina* beds. In addition, the genus *Waagenoconcha* is found in the *Omphalotrochus* beds of the Moscow basin. As witness, I refer to the fossil lists given for these beds by Ivanov.[8] *Productus humboldti* Orbigny in these lists is also referable to *Waagenoconcha*. Though further confirmation is desirable, this is very important evidence supporting that offered by *Omphalotrochus*.

The conclusions suggested here are seemingly not contradicted by evidence, such little as there may be, from the two groups of fossils on which so much reliance has been placed in Carboniferous and Permian correlations, the ammonoids and the fusulinids.

A. K. Miller[9] writes, under recent date, "We did not see the *Omphalotrochus* beds when we were in Russia and so far as I know they have yielded no significant ammonoids." Dunbar,[10] in his article, seems to assume that, since the *Omphalotrochus* and *Cora* beds are below the locally recognized "zone of *Schwagerina*," they are necessarily in the "zone of *Triticites*." He writes,[11] "Unfortunately, we did not have a chance to see the *Omphalotrochus* beds while we were in Russia and I have no satisfactory information on which to decide the age of these beds." And even if *Pseudoschwagerina* should be lacking and *Triticites* were present that would not be proof that the beds were in the "zone of *Triticites*." *Pseudoschwagerina* is commonly lacking locally or regionally from all or part of its complete range, and the genus *Triticites* passes upward from the "zone of *Triticites*" and ranges through the "zone of *Pseudoschwagerina*" as well. Hence, if the latter, or its distinctive fusulinid associates, are absent, and the former is present, one must rely on the recognition of species of *Triticites* or on fossils representative of other phyla to recognize the "zone of *Pseudoschwagerina*." Indeed, this last procedure is exactly what the present suggestion involves, the recognition of the "zone of *Pseudoschwagerina*" by the means of commonly associated fossils of other phyla when the genus that gives its name to the zone is itself lacking or is unreported.

It will be noted that I have not so far advocated the inclusion of the *Omphalotrochus* and *Cora* beds of the regions in question in either the Carboniferous or the Permian. I have only tried to point out that these beds seemingly must go with the *Pseudoschwagerina* beds, wherever these are placed. As a matter of fact, the recognition of these three groups of beds as forming a single series makes it even more advisable to include them along with overlying beds in our revised conception of the Permian. Both *Omphalotrochus* and *Waagenoconcha* make their first appearance in them, and both range up into the higher unquestioned Permian. Furthermore, if the interpretation suggested here is sustained, it will be seen that the hiatus beneath the *Omphalotrochus* beds, that is, the lower part of the Wolfcamp equivalent, is far greater in parts of Russia than has been supposed. In the Moscow basin, for instance, the *Omphalotrochus* beds rest on the Gshelian (C $\frac{2}{3}$) which Dunbar[12] places as approximately the age of the lower part of the Missouri

[8] A. P. Ivanov, "Depôts du Carbonifère moyen et supérieur du gouvernement de Moscou," *Bull. Soc. Naturalistesa Moscou*, Sec. Géol., T. 4 (1926), pp. 133–80.

[9] A. K. Miller, personal communication.

[10] Carl O. Dunbar, *op. cit.*

[11] *Idem*, personal communication.

[12] Carl O. Dunbar, *op. cit.*, p. 249.

group. In the Timan arch the *Omphalotrochus* beds seemingly rest on the middle Carboniferous (Moscovian) beds, the equivalents of the Des Moines group of this country, with all of the upper Carboniferous (Missouri and Virgil groups) out. In the Ufa plateau the upper Carboniferous may be present, but the information at hand is not sufficient to make certain.

The idea that the *Omphalotrochus* and *Cora* beds of the Timan arch and elsewhere must be regarded as a unit with the *Pseudoschwagerina* beds and that this unit should be placed in the Permian is not new. Grabau[13] advocated this idea in 1931, but his conclusions have been discounted by Dunbar[14] and others on the grounds that Grabau was forced to rely on Tschernyschew's work which is now known to be in error in respect to the stratigraphy in the Urals. But Tschernyschew seems to have interpreted correctly the section in the Timan arch, and Grabau's arguments, as based on data from this region, are as good as they ever were. Furthermore, Grabau was not unaware of the unreliability of Tschernyschew's work in the Urals for he quotes Fredericks to that effect,[15] although one can not see that he made any effective modification of Tschernyschew's fossil lists.

Carl O. Dunbar, Yale University, New Haven, Connecticut (manuscript received, April 10, 1940). I wish to endorse the very pertinent observations of Dr. Knight.

The Permian Excursion of the International Geological Congress did not visit any localities in which the *Omphalotrochus* beds were recognized. For that reason my recent discussion of "The Type Permian" avoided, in as far as possible, a commitment on the age of those beds. By inference they were left in the Carboniferous (where so commonly placed by the Russian geologists) because, having no first-hand evidence to the contrary, I considered this the most conservative course. It will be noted, however, that on page 249 of my paper, where the *Teguliferina* and the *Omphalotrochus* beds are both mentioned, the former (which we studied) were confidently dated, whereas no comment was made about the age of the latter. In the correlation chart (Fig. 9) the *Omphalotrochus* beds were placed in the Carboniferous horizon but with question marks both above and below intending to indicate that their position was quite uncertain.

My excuse for not having thoroughly analyzed Tschernyschew's work and noted the significance of *Waagenoconcha irginae* is that I feared the danger of compounding errors by relying on Tschernyschew's stratigraphy, and decided to stick to information which I could verify. However, I agree with Dr. Knight that Tschernyschew's collections within the Timan region were probably correctly zoned. The fossils given by Ivanov in his lists for the Moscow basin are also correctly zoned.

An effort will be made at once, through correspondence with Soviet geologists, to test the validity of the suggestion advanced by Dr. Knight.

Robert E. King, Shell Oil Company, Midland, Texas (manuscript received, May 1, 1940).—The suggestion by Dr. Knight that *Omphalotrochus*

[13] A. W. Grabau, *Natural History of Central Asia*, Vol. 4, *The Permian of Mongolia*, p. 7 *et al.*

[14] Carl O. Dunbar, *op. cit.*, p. 275.

[15] A. W. Grabau, *op. cit.*, p. 411.

and *Waagenoconcha* may not occur below the Permian is interesting in that it would reunite the divisions of the Uralian in the Permian, and would furnish two important supplementary guide fossils by which to identify the Permian in facies where fusulines and ammonoids are absent.

A review of literature on the upper Carboniferous and lower Permian of Eurasia suggests that data presented by different authors are so conflicting that correlation of almost any two stratigraphic units in that portion of the geological column could be supported by a certain amount of plausible evidence. Bearing in mind this reservation, I wish to call attention to the statement by Licharew[16] that "on the Northern and Southern Timan *Schwagerina princeps* is also associated with this gastropod [*Omphalotrochus*] and occurs in the lower part of the Uralian section." Whether the *Schwagerina princeps* referred to by Licharew is true *Schwagerina* or *Pseudoschwagerina* can not be ascertained from the citation, but in any case it is one of the fusulines of the *Pseudoschwagerina* zone, and current American usage would therefore place the *Omphalotrochus* beds of the Timan arch in the Permian on the basis of fusulines alone. The *Omphalotrochus* beds of the Urals are now placed in the Chernayarechka formation, which Dunbar correlates with basal Artinsk. Grabau has suggested that an arkosic sandstone at the base of the *Omphalotrochus* beds in the northern Timan indicates a significant unconformity, which would be at the base of the Permian as defined by Knight. However, Licharew[17] minimizes the significance of the suggested break.

An example of the value of *Waagenoconcha* as a supplementary guide to the Permian is in the classification of the "Upper Carboniferous" of the Andes, of which the brachiopods were admirably described by Kozlowski.[18] Here, *Waagenoconcha* is a characteristic form, but the other fossils which are commonly regarded as characteristic of the Permian are lacking. In 1930, I[19] pointed out that the brachiopods of the Andean "Upper Carboniferous" were most closely related to those in the lower Permian of West Texas, and suggested correlation of the Andean beds with the lower Permian. Berry,[20] however, stated that plant fossils from shales interbedded with the Andean "Upper Carboniferous" suggest Westphalian or early Stephanian age. On the other hand, Ting and Grabau[21] have shown that the Stephanian flora occurs in China in the zone of *Pseudoschwagerina*. I believe the evidence is now good that *Waagenoconcha* as well as *Omphalotrochus* is a Permian form, and feel that we can place the Andean beds in the Sakmarian, as recently implied by Dunbar.[22]

[16] B. Licharew, "Materials to the Study of the Upper Carboniferous of Ferghana," *Trans. Central Geol. and Prospecting Inst.*, Fasc. 31 (1935), pp. 16 and 36.

[17] B. Licharew, *op. cit.*, p. 37.

[18] R. Kozlowski, "Les Brachiopodes du Carbonifére supérieur de Bolivie," *Ann. de Paléontologie*, T. 9 (1914).

[19] R. E. King, "The Geology of the Glass Mountains, Texas," Part II, *Univ. of Texas Bull. 3042* (1930), pp. 35–36.

[20] E. W. Berry, "Carboniferous Plants Interbedded in the Marine Section of Bolivia," *Amer. Jour. Sci.*, Vol. 25 (1933), pp. 49–54.

[21] V. K. Ting and A. W. Grabau, "The Permian of China and Its Bearing on Permian Classification," *Rept. 16 Inter. Geol. Congress* (1936), pp. 664–66.

[22] Quotation by Raymond C. Moore, in "Carboniferous-Permian Boundary," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24 (1940), p. 324. Note by Carl O. Dunbar.—"I

The importance of *Omphalotrochus* and *Waagenoconcha* as Permian guide fossils may be shown by listing some other occurrences of these genera. *Omphalotrochus* and *Waagenoconcha* both occur in the Phosphoria, the former and *Pseudoschwagerina* in the McCloud limestone of northern California, and *Omphalotrochus* has been reported from the Providence Mountains of southeastern California,[23] possibly in association with a Permian fusuline fauna reported from that range by M. L. Thompson. *Waagenoconcha* is present in the Hueco, Leonard, and Word of West Texas, and in the Kaibab of Arizona, but it is absent from the American Pennsylvanian. The genus is represented in collections from many Asiatic and Arctic localities, from beds of Sakmarian and Artinskian age.

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have almost ready for publication a paper on the fusulines which were collected by Kozlowski along with the brachiopods which he described from Bolivia, and they strongly confirm the brachiopod evidence cited by King, that these beds are correlative with our Wolfcamp and the Sakmarian. They include species of *Pseudoschwagerina* as well as *Schwagerina*, both of which are very closely allied to forms from West Texas."

[23] H. E. Wheeler, "The Carboniferous-Permian Dilemma, *Jour. Geol.*, Vol. 42 (1934), p. 69.

MISSISSIPPIAN BORDER OF EASTERN INTERIOR BASIN

J. MARVIN WELLER AND A. H. SUTTON

CORRECTION

In the article, "Mississippian Border of Eastern Interior Basin," by J. Marvin Weller and A. H. Sutton, in the *Bulletin*, Vol. 24, No. 5 (May, 1940), page 802, footnote 11, "Broad Lead formation" should read *Brodhead formation.*

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REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by asterisk are in the Association library and available, on loan, to members and associates.

GEOLOGY OF NORTH AMERICA, BY MANY AUTHORS

REVIEW BY W. A. VER WIEBE[1]
Wichita, Kansas

Geology of North America. Vol. I: Introductory Chapters and Geology of the Stable Areas. Edited by Rudolf Ruedemann and Robert Balk with the collaboration of 16 other geologists. 643 pp., 14 pls., 53 figs. Published by Gebrüder Borntraeger, Berlin-Zehlendorf (September, 1939). Printed in English. Clothbound. Price, RM 16.

Approximately 14 years ago an ambitious plan was undertaken to publish a series of books on the Geology of the World. The editor-in-chief selected for this symposium was Professor Krenkel of the University of Leipzig. He selected outstanding authorities on each continent to serve as sub-editors. They in turn chose collaborators for various fields and areas to write chapters based on prolonged years of research. Rudolf Ruedemann, assistant State geologist of New York, was selected to collect and edit the chapters on North America. He was fortunate enough to secure the coöperation of J H. Bretz, Charles Schuchert, Curt Teichert, E. M. Kindle, M. E. Wilson, Charles Butts, C. W. Cooke, Paul Ruedemann, Julia Gardner, T. H. Clarke, G. M. Kay, E. R. Cumings, A. S. Warthin, and G. S. Hume to write chapters for the first volume. Before all manuscripts had been received it became necessary for Dr. Ruedemann to resign the editorship which he had held since 1927. In 1935 the difficult task of coördinating the material and getting the first volume ready for the press was entrusted to Robert Balk of Mount Holyoke College. Late in 1939 the first volume of the three-volume set appeared.

This volume covers eastern and central Canada, Greenland, and a considerable portion of the United States. The introductory chapter by J H. Bretz describes the Physiography of North America very completely and thus lays the foundation for all three volumes. The second chapter is similarly inclusive and gives the reader a comprehensive view of the general geology of the whole continent. The origin of the continent, the trend lines, the origin and cause of the mountain chains are presented according to various divergent but nevertheless authoritative viewpoints. In the third chapter Dr. Schuchert presents his most recent findings and conclusions regarding geosynclines, borderlands, and geanticlines. A number of paleogeographic maps bring the information regarding the fundamental elements of the architecture of the continent up to date. The following chapter by Rudolf Ruedemann on Paleogeography introduces several of the newer concepts and summarizes

[1] Department of Geology, University of Wichita. Manuscript received, April 25, 1940.

very ably the large fund of information now available on that topic. A chapter on the Climates of the Past beginning with pre-Cambrian time and extending to the Present rounds out the first portion of the volume.

The remainder of the volume is concerned with more limited areas and more specific details. It is introduced by a most fascinating account of the geology of Greenland. This particular chapter is most exhaustive and brings together facts and conclusions regarding this part of the continent which have heretofore been scattered through the literature of several languages. Since much of the original material is not accessible to the average reader, this chapter will prove unusually valuable. In Chapter VII E. M. Kindle outlines the geology of the Arctic archipelago and the interior plains of Canada. This vast region has been explored more fully than might be expected and the data made available to the reader are, therefore, surprisingly complete. The Canadian Shield forms the topic for the next chapter and concludes the portion devoted to northern North America.

In Chapter IX Charles Butts reviews the knowledge regarding the Appalachian Plateau region accumulated through a century of geological investigation. He also summarizes the information now at hand on the rather large area between the Appalachian Plateau and the Mississippi River. Chapter X is devoted to the stratigraphy and structural geology of the southern part of the Central Lowlands and the Ouachita Province. The next to last chapter which concerns the Atlantic Coastal Plain and the Gulf Coastal Plain was written jointly by three authorities. The physiography, general geology, and details of the Cretaceous system were prepared by L. W. Stephenson and the portion devoted to the stratigraphy of the Tertiary was written jointly by C. W. Cooke and Julia Gardner. The final chapter is also the joint contribution of a number of authors. It presents details regarding the Canadian extension of the Interior Basin of the United States. The Ordovician, Silurian, and Devonian rocks of Ontario are separately treated. Special attention is also given to the Paleozoic outliers on the pre-Cambrian Shield and to the St. Lawrence Lowlands of Quebec.

A catalogue of the new data brought together in this volume can not be compressed into a review. It is also impossible to enumerate the points of excellence in the many maps, comparative stratigraphic tables and bibliographies. The reader who acquires the book will find it the most scholarly and up-to-date summary in the English language as well as an indispensable source book.

The publishers propose to issue a second volume which will contain articles on the Cordilleran Mountains and the western part of North America. It will also contain special chapters on the Appalachian Mountains and on the Hawaiian Islands. The third volume of the set will be devoted to articles on Mexico and Central America as well as comprehensive papers on mineral resources, igneous rocks, and structural problems.

RECENT PUBLICATIONS

BRAZIL

*"New Fossil Localities of Northeast Baia," by José Lino de Melo Junior and Paulo Erichson de Oliveira. *Divisão de Geologia e Mineralogia Bol. 103*

(Rio de Janeiro, 1939). 85 pp., 10 photographs, 2 maps. In Portuguese. Explanation and Summary, pp. 5–9, in English.

CALIFORNIA

*"Possibilities of Miocene Production in the Inglewood Field," by W. E. Dunlap. *California Oil World* (Los Angeles), Vol. 33, No. 8 (Second Issue, April, 1940), pp. 49–55, 64; map, section, 4 photographs.

COLORADO

*"Lime-Secreting Algae and Algae Limestones from the Pennsylvanian of Central Colorado," by J. Harlan Johnson. *Bull. Geol. Soc. America* (New York), Vol. 51, No. 4 (April 1, 1940), pp. 571–96; 10 pls., 4 figs.

ENGLAND

*"The Triassic Rocks of North-West Somerset," by A. N. Thomas. *Proc. Geol. Assoc.* (London), Vol. 51, Pt. 1 (March 29, 1940), pp. 1–43; 8 figs., 3 pls.

EUROPE

**The Mineral Map of Europe*, prepared by the geological department of The Pure Oil Company, Theron Wasson, chief geologist. 31×27 inches, in colors. *Supplementary Data* of 61 pp., in book form, bound in blue cloth, approx. 13×11.25 inches. "The accompanying Mineral Map shows Europe's mines and oil fields, together with the proportion of world output produced therein. Europe's reserves, deposits, production, consumption, sufficiencies or deficiencies are shown in the following tables." The Pure Oil Company, Chicago, Illinois (1940). Price, $3.50.

GENERAL

*"Forest City Basin Not Providing Great Deal of Oil Excitement," by W. V. Howard. *Oil and Gas Jour.* (Tulsa), Vol. 38, No. 51 (May 2, 1940), pp. 18–19; 3 geologic sections and a map.

A Handbook of Rocks, for Use Without the Petrographic Microscope, by James Furman Kemp. Sixth edition (1940), completely revised and edited by Frank F. Grout, with a memorial to Professor Kemp by Charles P. Berkey. 300 pp., including a "List of Rock Names Not in Index," 96 figs. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Cloth. Price, $3.00, net.

*"Report of the Committee on Petroleum Reserves," *Amer. Petrol. Inst. Quar.* (50 West 50th Street, New York), Vol. 10, No. 2 (April, 1940), pp. 8–9. Committee: J. Edgar Pew, chairman, R. F. Baker, L. T. Barrow, Frank R. Clark, G. Clark Gester, F. H. Lahee, J. M. Sands, Fred Van Covern, Theron Wasson, Fred E. Wood.

"Recent Progress in Petroleum Development and Production," by H. C. Miller and G. B. Shea. 89 pp. Reprinted from a hearing before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, Seventy-Sixth Congress. U. S. Bureau of Mines, Section of Publications, Washington, D. C., has limited supply.

*"Aerial Photographs Furnish Valuable Aid to Geologists," by W. V. Howard. *Oil and Gas Jour.* (Tulsa), Vol. 38, No. 51 (April 18, 1940), pp. 52–53; 4 photographs.

*"Geochemical Well Logging," by E. E. Rosaire. *Ibid.* (April 25, 1940), pp. 114, 116, 119; 2 charts.

*"Some Structural Examples of Micromagnetic Prospecting," by W. P. Jenny. *Ibid.*, pp. 132–34, 139; 5 figs.

*"Aerial Photographic Surveys Valuable on Gulf Coast," by W. V. Howard. *Ibid.*, pp. 194–95; 2 photographs.

*"Electrical Well Logging and Core Analysis," by P. B. Leavenworth. *Ibid.*, pp. 197–201; 3 figs.

*"A.A.P.G.'s Growth Parallels Expansion of Petroleum Industry," by J. Elmer Thomas, *Ibid.* (April 11, 1940), pp. 30–40.

*"Society of Economic Paleontologists and Mineralogists Firmly Established," by Raymond C. Moore. *Ibid.*, pp. 42, 59.

*"Society of Exploration Geophysicists Celebrate Tenth Anniversary," by W. T. Born. *Ibid.*, p. 45.

*"Analyses Present Evidence of Origin of Petroleum," by W. V. Howard. *Ibid.*, pp. 46, 59.

*"Oil-Field Development Is a Geological Enterprise," by Wallace E. Pratt. *Oil Weekly* (Houston), Vol. 97, No. 5 (April 8, 1940), pp. 22–23, 100.

*"Wildcat Drilling in 1939," by Frederic H. Lahee. *Ibid.*, pp. 32–33, 92.

*"A.A.P.G.," by Henry A. Ley. *Ibid.*, p. 35.

*"Growth of Petroleum Geology a Parallel to Modern Oil Achievement," *Anon. Ibid.*, pp. 36–37, 41–50, 82–90.

*"Paleontology Increases in Oil Application," by Marcus A. Hanna. *Ibid.*, pp. 54–58.

*"Exploration Geophysics—Ten Years with the Society," by Paul Weaver. *Ibid.*, pp. 62–64.

*"History and Development of Seismic Prospecting," by B. B. Weatherby. *Ibid.*, pp. 67–69.

*"Gravity Method Produces Results at Low Cost," by E. A. Eckhardt. *Ibid.*, pp. 71–75.

*"Geophysical Applications in the Production of Oil," by W. T. Born. *Ibid.*, p. 76.

*"Early Geophysics in the First Person," by D. W. Ohern. *Ibid.*, p. 78.

*"Range of the Redwall of Grand Canyon," by Charles Keyes. *Pan-American Geologist* (Des Moines, Iowa), Vol. 73, No. 4 (May, 1940), pp. 269–81.

*"Mineralogic Determination of Oil Drilling Chippings," by William F. Tanner. *Ibid.*, pp. 282–88.

*"Sequential Order of the Red-Beds," by Charles Keyes. *Ibid.*, pp. 289–94; 1 fig.

**Annotated Bibliography of Economic Geology for 1939.* Vol. 12, No. 1 (February, 1940). 176 pp. Prepared under the auspices of the Society of Economic Geologists. *Economic Geology*, Urbana, Illinois. Price, $5.00 per year.

*"Annual Report of the Petroleum and Natural Gas Division, Fiscal Year 1939," by R. A. Cattell *et al. U. S. Bur. Mines R. I. 3501* (March, 1940). 41 multigraphed pp., 2 figs.

*"Sand Movements along the Scripps Institution Pier," by Francis P. Shepard and Eugene C. LaFond. *Amer. Jour. Sci.* (New Haven, Connecticut), Vol. 238, No. 4 (April, 1940), pp. 272–85; 5 figs.

*"Paleozoic Pelecypods *Myalina* and *Naiadites*," by Norman D. Newell. *Ibid.*, pp. 286–95; 2 pls., 2 figs.

*"Size Distribution of Source Rocks of Sediments," by W. C. Krumbein and F. W. Tisdel. *Ibid.*, pp. 296–305; 2 figs.

*"Submarine Valleys and Related Geologic Problems of the North Atlantic," by Walter H. Bucher. *Bull. Geol. Soc. America* (New York), Vol. 51, No. 4 (April, 1940), pp. 489–512.

*"Sierra Nevada Tectonic Pattern," by Augustus Locke, Paul Billingsley, and Evans B. Mayo. *Ibid.*, pp. 513–40; 2 pls., 1 fig.

ILLINOIS

Midwest Oil Journal Semi-Annual Directory, 1940. 132 pp. Alphabetical directory, particularly of Illinois basin area. Published by *Midwest Oil Journal*, Centralia, Illinois. Price, $2.00.

MISSISSIPPI

*"Fields Better Than Tinsley Likely for Mississippi," by John D. Todd. *Oil Weekly* (Houston), Vol. 97, No. 6, (April 15, 1940), pp. 17–26; 5 pls.

MONTANA

*"Upper Cambrian Formations in Southern Montana," by Erling Dorf and Christina Lochman. *Bull. Geol. Soc. America* (New York), Vol. 51, No. 4 (April 1, 1940), pp. 541–56; 5 pls., 2 figs.

TEXAS

East Texas Oil Field Directory. 1940 edition, compiled by G. E. Wimberly, Kilgore, Texas, 42 pp.

Texas Petroleum Register, 1940. 264 pp. Published by R. W. Byram and Company, 104 East 13th Street, Austin, Texas. Price, $10.00.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 24, NO. 6 (JUNE, 1940), PP. 1139-1149, 2 FIGS

THE ASSOCIATION ROUND TABLE

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

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WEST TEXAS GEOLOGICAL SOCIETY STUDENT MERIT AWARDS

The West Texas Geological Society, of Midland, Texas, on July 21, 1939, approved a Student Award Plan, presented by W. C. Fritz and Berte R. Haigh, providing for awards to graduates of the geological departments of the Texas Technological College at Lubbock, Texas, and the Texas College of Mines and Metallurgy at El Paso, Texas. The award consists of a 2-year paid-up associate membership in The American Association of Petroleum Geologists. In addition to the award of the West Texas Geological Society, the Association presents the honoree with a copy of the latest Association book or copies of the previous year's *Bulletin*.

The two students selected for the 1940 merit awards are George Terrell Thomas and Robert Alfred Whitlock, Jr.

George Terrell Thomas, B.A. (geology, 55 hours), June, 1940, Texas Technological College, Lubbock, Texas (1934–1940). Born, February 3, 1913, Cuero, Texas. Preparatory, Lubbock High School, 1926–1930. Experience: 1930–1933, shipping clerk and salesman, Sansom Paint Company, Lubbock; 1935–1938 (summers), roustabout and scout, Ohio Oil Company, Hobbs, New Mexico. Student assistant in geology department; active member, Sigma Gamma Epsilon; student associate, Amer. Inst. Min. Met. Engineers.

G. T. Thomas

Robert Alfred Whitlock, Jr., B.A. (geology, 38 hours), June, 1940, Texas College of Mines and Metallurgy, El Paso, Texas (1935–1940). Born, June 17, 1915, El Paso, Texas. Preparatory, El Paso High School. Experience: filling station attendant, Hays Brothers Standard Service Station. Student Council, 1937–1938; Scientific Club; part-time assistant in geology department; student associate, Amer. Inst. Min. Met. Engineers.

R. A. Whitlock, Jr.

COMMITTEE APPOINTMENTS

The attention of the members is called to the revised lists of the personnel of the Association's standing and special committees for this year, which will be found on other pages of this *Bulletin*. The appointments and re-appointments devolving upon me have been made after considerable thought and after consultation with the chairmen of the committees in nearly all cases, and with the presidents of sections of the Association or of affiliated societies in several.

The fundamental consideration in making these appointments has been the successful conduct of the work of the Association, but attention has also been given to the different fields of interest of the membership and to the problem of geographic distribution.

The retiring committeemen deserve the thanks of the Association and the continuing and new ones the full coöperation of the membership, which can be displayed best by each member freely bringing to their attention any suggestion or problem which falls in the field of the respective committees.

L. C. SNIDER

NEW YORK CITY
May 23, 1940

COMMITTEE ON MIMEOGRAPHED PUBLICATIONS

The revised list of Association committees in this *Bulletin* contains a new special committee whose function it is to study the relative merits and costs of mimeographing and other methods of reproduction, more economical than printing, for special reports which would probably cover too restricted a field to warrant the type of publication we have used hitherto and yet be of interest to a sufficient number of members to justify publication by some cheaper process. The committee is to recommend a process for a particular report for which an appropriation has been made. By resolution of the executive committee, the new committee consists of the trustees of the revolving publication fund, the chairman of the research committee, and three members appointed by the president. The appointed members are Frank R. Clark, chairman of the committee, Frederic H. Lahee, and A. E. Brainerd. Members of the Association are urged to give the committee the benefit of any experience they may have had along the lines of this contemplated entry into a new series of publications.

L. C. SNIDER

NEW YORK CITY
May 23, 1940

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HAROLD N. HICKEY		NORMAN D. NEWELL
		CHARLES W. TOMLINSON

COMMITTEE ON APPLICATIONS OF GEOLOGY

CARROLL E. DOBBIN (1943), *chairman*, U. S. Geological Survey, Denver, Colo.
HENRY C. CORTES (1941), *vice-chairman, geophysics*, Magnolia Petroleum Co., Dallas, Tex.
CAREY CRONEIS (1943), *vice-chairman, paleontology*, University of Chicago, Chicago, Ill.

1941	1942	1943
HAL P. BYBEE	LUTHER E. KENNEDY	H. S. MCQUEEN
E. E. ROSAIRE	CHALMER J. ROY	B. B. WEATHERBY
	EARL A. TRAGER	

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COMMITTEE ON COLLEGE CURRICULA IN GEOLOGY

FREDERIC H. LAHEE, *chairman*, Sun Oil Company, Dallas, Texas

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WALTER R. BERGER	K. K. LANDES	E. K. SOPER
HAL P. BYBEE	HENRY A. LEY	W. T. THOM, JR.
	JOHN T. LONSDALE	

COMMITTEE TO RECOMMEND A NEW METHOD OF ELECTING OFFICERS

GEORGE S. BUCHANAN, *chairman*, Box 2199, Houston, Texas

N. WOOD BASS	J. V. HOWELL	JOHN N. TROXELL
GLENN C. CLARK	L. C. MORGAN	W. B. WILSON

COMMITTEE ON MIMEOGRAPHED PUBLICATIONS

FRANK R. CLARK, *chairman*, The Ohio Oil Company, Tulsa, Oklahoma

ARTHUR E. BRAINERD	FREDERIC H. LAHEE	E. FLOYD MILLER
GEORGE S. BUCHANAN	A. I. LEVORSEN	FRANK A. MORGAN

REPORT OF REPRESENTATIVE OF THE ASSOCIATION ON DIVISION OF GEOLOGY AND GEOGRAPHY OF NATIONAL RESEARCH COUNCIL[1]

FREDERIC H. LAHEE[2]
Dallas, Texas

To the Executive Committee:

On April 27, 1940, the Division of Geology and Geography of the National Research Council convened in Washington for presentation and discussion of annual reports of its several committees. As representative of our Association, I attended this meeting. I shall briefly outline the substance of those reports which may be of interest to Association members.

J. A. Cushman, chairman of the Committee on Micropaleontology, referred to faunas secured from cores taken from the ocean bottom at points far removed from land. These include fossils of Cretaceous and Tertiary age. Some are related to known faunas found in our present land sections while others do not seem to correlate with any known faunas.

Dr. Cushman reiterated his oft repeated warning to the effect that environmental (ecologic) conditions may be more significant than time relations in controlling the distribution of foraminiferal groups. He called attention to the desirability of avoiding duplication of effort in research.

Parker D. Trask, chairman of the Committee on Sedimentation, mentioned publication by this Association, of *Recent Marine Sediments*. Of especial importance is the fact that only 1,511 copies were printed, after which type was broken down so that there can be no second printing after this edition has been exhausted. This brings to a conclusion the period of study concentrated on recent sediments. The committee has now been reorganized for research on problems concerning ancient sediments.

C. R. Longwell, chairman of the Committee on Tectonics, announced that 200 copies of the tectonic map of the United States had been printed and distributed for corrections and additional information. After full opportunity has been given for submitting criticisms, the committee will prepare the map for final publication. This should be before the end of the present year.

Carl O. Dunbar, chairman of the Committee on Stratigraphy, reported further progress on the correlation charts which have been in course of preparation for several years. Arrangements have been made to publish these, one by one as they are completed, in the *Bulletin* of the Geological Society of America. The first of them should soon appear in print. These charts refer for the most part to outcropping formations, but in some districts, where important formations are not exposed but are known in the subsurface, these are likewise included. In the discussion particular attention was called to certain subsurface Permian formations, and also to Cretaceous, Comanche, and Jurassic strata of northern Louisiana and southern Arkansas.

W. H. Twenhofel, chairman of the Committee on Conservation of the Scientific Results of Drilling, reviewed the history of the committee, and cited the conclusions reached by the present members, (1) that direction or advice

[1] Report received, May 3, 1940.

[2] Chief geologist, Sun Oil Company.

by the committee as to despositories for well samples seemed futile; (2) that the committee, after willing efforts to assist water-well drillers' associations, found that help was seldom wanted; and (3) that it could give no substantial assistance to companies drilling for oil since these companies already had efficient methods of collection, preservation, and study of samples.

As a result of these conclusions, Dr. Twenhofel cited the recommendation of his committee that it be dismissed, having accomplished all that seemed feasible or possible under existing circumstances.

F. H. Lahee, as representative of the Association, presented to the Division his report on the research activities of the Association, and on other related matters.

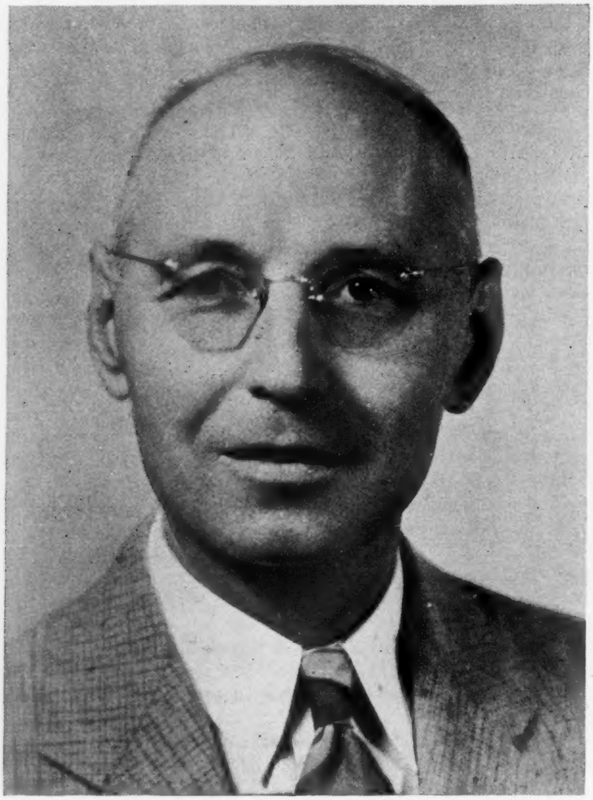
At the conclusion of the meeting, appointment of A. I. Levorsen was confirmed, to serve as representative of the Association on the Division for the 3-year period beginning, July 1, 1940, succeeding F. H. Lahee, whose term ends June 30.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 24, NO. 6 (JUNE, 1940), PP. 1150-1153, 2 FIGS.

Memorial

HENRY ARTHUR NEDOM
(1895-1940)

Henry Arthur Nedom was born, March 27, 1895, in Ellsworth, Kansas, and died of bronchial pneumonia on March 7, 1940, in a Tulsa, Oklahoma,



HENRY ARTHUR NEDOM

hospital. He is survived by his wife, Pearle, and one son, Arthur, whose home is at Tulsa. Also surviving him are his parents, Mr. and Mrs. Joseph Nedom

of Los Angeles, California, and three brothers. Interment was at Shelby, Nebraska.

At an early age he moved with his parents to Nebraska. In 1914 he entered the Shelby High School where he graduated the following year. He entered the University of Nebraska in 1916, graduating in 1921 with a Bachelor of Science degree in geology.

On June 15, 1921, following his graduation, he was married to Pearle Swan, a high school classmate. Arthur is their only child.

He then took post-graduate work in geology toward a Ph.D. degree until 1926. During this latter period Henry was a member of the geology department faculty at the University of Nebraska. He was a member of Sigma Gamma Epsilon, national geological fraternity, and Sigma Xi, national scientific research fraternity. In January, 1929, he was elected to membership in the American Association of Petroleum Geologists, sponsored by Elfred Beck, Kent K. Kimball, and E. F. Shea.

His first employment in geological work was in 1918–19, doing detailed mapping for the Empire Gas and Fuel Company at Bartlesville, Oklahoma. For six months in 1919 he also did detailed map work for the York State Oil Company at Caney, Kansas. During the summer months of 1923 and 1924, Henry was employed by the Plum Creek Syndicate of New York, doing detailed geologic field work in Wyoming, South Dakota, and Nebraska.

After completing his study at the University of Nebraska, Henry took his family with him to Maracaibo, Venezuela, where he worked for two years as assistant chief geologist for the Lago Petroleum Corporation. In 1929 he returned to Oklahoma as chief geologist for the Midwestern Petroleum Company and the Midwestern Oil and Gas Company, where I was associated with him.

During this period he mapped all of the important structural features in eastern Oklahoma, and was probably the first geologist to differentiate the members of the Winslow group and correlate the units north of the Arkansas River with the stratigraphic equivalents to the south. From my personal observation of his work during this period, I know that he was one of the best men in surface work with whom it has ever been my pleasure to be associated.

At the conclusion of this period of work, he made a survey of the gas-producing areas in Arkansas and Louisiana, together with surveys embracing Mississippi, Pennsylvania, West Virginia, and New York, finally working out several important features in the state of Mississippi in 1932. He was always insistent of the producing possibilities of that area, and his interest in the geologic problems and desire to follow the current development resulted in over-work which undermined his health and hastened his death.

Henry left uncompleted a book he was writing under the title "Cobwebs and Progress," to be used as a classroom textbook on the relationship between science and sociology.

In 1932 he settled in Tulsa, Oklahoma, with his family, where he resided until his death.

People who did not know Henry personally missed the joy of having an association with one of the finest characters I have ever known.

EARL G. COLTON

SAN ANTONIO, TEXAS
April 9, 1940

RALPH DANIEL REED
(1889–1940)

The death of Ralph Daniel Reed on January 29 last brought to a premature close one of the most distinguished careers in the field of petroleum geology. He excelled not alone in this specialized field of science. His rare talent for critical analysis of geologic data enabled him clearly to visualize

G. Edwin Williams Studio

RALPH DANIEL REED

the broader and more fundamental aspects of historical and structural geology. This talent is amply demonstrated in his numerous contributions to the geology of California, published chiefly by the Association either in the *Bulletin* or as special publications. He was taken in the prime of his mental vigor, with much material yet to be completed for publication.

Biographical details were recorded in the December issue of the *Bulletin*, on the occasion of his election to honorary membership in the Association. It is a source of general satisfaction that this honor was awarded and publicly acclaimed at a time when he could share the merited distinction with his family. He is survived by his wife and three children: a son, Ralph W., a geologist now in the service of the Philippine Government, and two daughters, Elizabeth, eighteen, and Helen, fourteen.

Ralph Reed's passing is a great loss to the Association and the profession; but to each of his many friends it is a very poignant and personal loss. His simplicity, self-effacement, kindliness, dry whimsical humor, and rare strength of character commanded the affectionate regard of all who knew him. Men of his type are all too few. His death leaves an unbridgeable gap in the ranks of those who remain.

The tribute of Doctor Theodore Soares, read at the funeral services in Pasadena on February 1, 1940, voices the unexpressed thoughts of colleagues and friends, and throws significant light on Ralph's attitude toward life. To quote in part, Dr. Soares said:

> I have known Doctor Reed only a few weeks, but from the intimate talks I have had with him beside his bed I feel that I can understand why his friends speak of him with such affection and admiration. I can see how natural and sincere was the tribute paid to him in connection with his election to honorary membership in the professional association, of which he had been president. In that tribute there is not only the recognition of the scholar, the scientific leader, the man of research, but a deep regard for noble character and generous comradeship.
>
> It is not difficult to see why the young men followed him with such devotion, for, as he talked of his work, I could see how deeply he had the success of his younger colleagues in his heart and how generously the man who had attained was watching and helping the progress of those who were coming on.
>
> We have all admired his courage as he met the hard necessity of his painful illness. Ten years ago they told him that he had but a short time to live. His concern then was for the wife and the young children he would leave behind. But he set himself to work for all the days that were possible. As he looked back he forgot his pain in the happiness that he had had the opportunity better to provide for those he loved.
>
> In my brief acquaintance with this man, whom I seemed to know at once so well, we spoke with more frankness of the meaning of life and death than I have ever used before with anyone so seriously ill. Usually even in the last days we must not allow the sufferer to know that we do not look for his recovery. It seems to be proper to preserve to the last the illusion of the promise of health. But he wanted no such pretense. He spoke freely of the inevitable brevity of the time that was still his. And then we talked about the future.
>
> His keen scientific mind would not accept the ordinary proofs that are offered for immortality. We came near together when I agreed that there is no proof that the human spirit can survive death. Then with no barrier between us we could discuss the experience through which he was so soon to pass with quiet judgment and appraisal and even with a touch of humor as some suggestion of incongruity brought the winsome smile to his lips.
>
> We talked of the great values of life—the love of home and friends, the devotion of duty, loyalty to a trust, the immortality of the teacher in his students, of the leader in his followers, truth, goodness, beauty. The physical man could not survive death but what of the spiritual man—the personality that had developed in the finer strivings. He smiled and agreed, "Yes, if there is anything after death it will be the survival of those elements of goodness and of love." So we left it there—where all of us must leave it.

W. E. WRATHER

DALLAS, TEXAS
May 15, 1940

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 24, NO. 6 (JUNE, 1940), PP. 1154–1156

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

CHARLES N. GOULD, of Norman, Oklahoma, spoke on "Early Geologists in Oklahoma," at the annual banquet of Sigma Gamma Epsilon, geological fraternity at the University of Oklahoma, May 1.

PAUL H. PRICE, State geologist of West Virginia, recently discussed "The Future of Natural Gas Fuels in West Virginia" before a joint meeting of the Appalachian Geological Society, the Clarksburg Oil and Gas Men's Club, and the Oil and Gas Section of the Engineer's Society of West Pennsylvania, at Charleston, West Virginia.

FRANK G. EVANS, of the Shell Oil Company, Inc., recently discussed "The Photographic Interpretation of Part of the Texas Gulf Coast," before the Houston Geological Society.

KENNETH A. ELLISON, consulting geologist, discussed the Ramsey Petroleum Company's deep test in Canadian County, Oklahoma, before the Oklahoma City Geological Society, April 29.

H. G. WALTER, recently with The Texas Company at Pampa, Texas, is now with The Ohio Oil Company at Findlay, Ohio.

P. B. NICHOLS, of the Indian Territory Illuminating Oil Company, talked on "Value of Drilling Time in the Seminole Area," before the Shawnee Geological Society, Shawnee, Oklahoma, April 22.

RICHARD R. PRIDDY, recently with the Kingwood Oil Company, has been appointed assistant geologist on the Mississippi Geological Survey.

KENDALL E. BORN of the Tennessee State Division of Geology, Nashville, recently addressed the Shreveport, Louisiana, Geological Society on "Structural Studies in Central Tennessee."

JOHN R. FANSHAWE is in the employ of the Ohio Oil Company, 108 West Third Street, Bloomington, Indiana.

WILLIAM L. RUSSELL is with Well Surveys, Inc., Tulsa, Oklahoma.

CLINTON A. LUETH is employed by W. C. McBride, Inc., San Antonio, Texas.

GILBERT A. TALLEY may be addressed in care of the Exchange Oil Company, Box 99, Jackson, Mississippi.

W. W. NEWTON, formerly supervisor of field parties of the Geotechnical Corporation of Delaware, has been elected vice-president at 1702 Tower Petroleum Building, Dallas, Texas.

ALTAVINO E. CATINARI, formerly with the Richfield Oil Corporation at Los Angeles, California, is with the Argentine Government Oil Fields (Y.P.F.), Departmento Exploracion, Buenos Aires.

PHIL K. COCHRAN has resigned the position of division geologist in Kansas

for the Carter Oil Company to accept the position of chief geologist of the Standard Oil Company of Louisiana, at Shreveport, Louisiana.

LINN M. FARISH, president of the Northeastern Ohio Geological Society, Box 629, Youngstown, Ohio, has planned a field trip of several days, beginning at Pittsburgh, June 20, and ending at Niagara Falls, June 25. The area around Pittsburgh is covered by guidebooks published by the Pennsylvania Geological Survey, also the greater part of the route across state. In New York the party plans to follow the excursion of the 16th International Geological Congress of 1933 (Guidebook 4, Excursion A-4).

SAM W. WELLS and C. B. PETERS, of Tulsa, are operating as the Norbia Oil Company in Corpus Christi, Texas.

MAYNARD P. WHITE, of the Gulf Oil Corporation, presented a paper on Foraminifera before the Ardmore Geological Society, Ardmore, Oklahoma, June 3.

VAUGHN C. MALEY, geologist with the Humble Oil and Refining Company, has moved from Midland, Texas, to Hattiesburg, Mississippi, where he has charge of geological work for his company.

RICHARD HUGHES is situated at 606 First National Bank Building, Grand Rapids, Michigan.

GEORGE S. HUME, of the Geological Survey of Canada, Toronto, delivered several lectures, this spring, on Canadian and world problems in petroleum, at Queen's University, Kingston.

R. A. PELLETIER is president of the Geological Society of South Africa.

HEINRICH RIES, of Ithaca, New York, lectured last March on "Engineering Geology Features on the West Coast," before the department of geology at the University of Toronto.

C. A. BONINE, head of the department of geology at the Pennsylvania State College, has been touring the oil states of the southwest and is spending the summer in California.

EDWIN S. SMITH, JR., has a consulting geology office at 1912 Wilbarger Street, Vernon, Texas.

M. B. ARICK is exploration geologist for the Standard Oil Company of Venezuela, with headquarters at Trujillo, Dominican Republic.

FRANK S. MILLARD is engaged in electrical coring work for the Mene Grande Oil Company at Barcelona, Venezuela.

The Shreveport Geological Society, E. FLOYD MILLER, president, announces that it is reprinting the guide book of its fourteenth annual field trip of June 2–4, 1939. The first edition of 700 copies was sold out in 1939 within 2 weeks of its initial printing. Demands for additional copies have convinced the Society of the need for a second printing. The book will not be altered in any way. It is entitled, "Upper and Lower Cretaceous of Southwest Arkansas, Supplemented by Contributions to the Subsurface Stratigraphy of

South Arkansas and North Louisiana," and contains 30 chapters or contributions by 23 authors. There are 216 pages including advertisements and 60 pages of illustrations (stratigraphic sections, structure-contour maps, correlation tables, diagnostic fossils, folded cross sections, route maps). The book is in "plastic" binding, from the Journal Litho Press, Shreveport. Page size, 8.5×10.875 inches. The original price of $3.00 will be maintained. Those interested in purchasing a copy should communicate with E. WELDON CARTWRIGHT, secretary-treasurer, Shreveport Geological Society, 809 Giddens-Lane Building, Shreveport, Louisiana.

W. C. KRUMBEIN, of the University of Chicago, gave an informal talk on "Fundamental Properties of Sediments in Relation to Environments of Deposition" before the Illinois Geological Society at Centralia, Illinois. Krumbein will spend the summer in California working under a research grant of the Geological Society of America.

One of the recent speakers before the department of geology and geography at Northwestern University was DAVID G. THOMPSON, senior geologist of the Ground Water Division, U. S. Geological Survey, who spoke on "Ground-Water Problems in Ohio."

The biennial Grant Memorial lectures, commemorating the work of Professor U. S. GRANT, formerly chairman of the department of geology and geography at Northwestern University, were given this year by Professor ROLLIN T. CHAMBERLIN, of the University of Chicago. Professor Chamberlin gave a series of lectures on the structure of the northern Rockies, and a lecture for laymen dealing with the subject of earthquakes.

The following officers of the Tulsa Geological Society have been elected: president, JOSEPH L. BORDEN, Pure Oil Company; vice-president, JOHN G. BARTRAM, Stanolind Oil and Gas Company; second vice-president, RONALD J. CULLEN, Sun Oil Company; secretary-treasurer, L. M. WILSHIRE, Skelly Oil Company; editor, JOHN L. FERGUSON, Amerada Petroleum Corporation; associate editor, HIRAM J. TANDY, independent.

The Indiana-Kentucky Geological Society held its May meeting at Bloomington, Indiana, May 17, when RALPH E. ESAREY, State geologist of Indiana, spoke on "The History of the Old Trenton Production of Indiana," and ALLEN FOSTER, Phillips Petroleum Company, presented a cross section of the Chester series in southwestern Indiana. The following day, C. A. MALOTT, department of geology, University of Indiana, and RALPH E. ESAREY, conducted a field trip to the Chester outcrops in southern Indiana. Approximately 80 geologists attended the trip in about 30 cars.

HENRY A. LEY, vice-president of the Southern Cross Oil Company, San Antonio, Texas, spoke before the seventeenth annual meeting of the National Oil Scouts and Landmens Association at Hot Springs, Arkansas, May 31. His subject was "Eyes of the Petroleum Industry." JOSEPH M. DAWSON, consulting geologist of Jackson, Mississippi, spoke on "Geology and Development of Mississippi."

PAUL L. APPLIN, geologist with the Cosden Petroleum Corporation, Fort Worth, Texas, spoke recently before the Oklahoma City Geological Society on "Cosden-Zweifel Pool in Young County, Texas."

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DENVER, COLORADO

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810 U. S. National Bank Building
1st Vice-President - - - - - E. H. Stevens
Colorado School of Mines, Golden
2nd Vice-President - - - - - - Ninetta Davis
224 U. S. Customs Building
Secretary-Treasurer - - - - - Dart Wantland
927 Humboldt Street

Dinner meetings, first and third Mondays of each month, 6:15 P.M., Auditorium Hotel.

ILLINOIS

ILLINOIS GEOLOGICAL SOCIETY

President - - - - - - - Melville W. Fuller
Carter Oil Company, Mattoon, Box 568

Vice-President - - - - - Maxwell B. Miller
The Texas Company, Mattoon

Secretary-Treasurer - - - James G. Mitchell
The Pure Oil Company, Clay City

Meetings will be announced.

KANSAS

KANSAS GEOLOGICAL SOCIETY
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Gulf Petroleum Corporation
Vice-President - - - - - - Harold O. Smedley
Skelly Oil Company
Secretary-Treasurer - - - - - Lee H. Cornell
Stanolind Oil and Gas Company
Manager of Well Log Bureau - **Harvel E. White**

Regular Meetings: 7:30 P.M., Allis Hotel, first Tuesday of each month. Visitors cordially welcomed.

The Society sponsors the Kansas Well Log Bureau which is located at 412 Union National Bank Building.

LOUISIANA

THE SHREVEPORT GEOLOGICAL SOCIETY
SHREVEPORT, LOUISIANA

President - - - - - - - - - - E. F. Miller
Oliphant Oil Corp., 911 Commercial Bank Bldg.
Vice-President - - - - - - - - - J. D. Aimer
Arkansas Fuel Oil Company
Secretary-Treasurer - - - Weldon E. Cartwright
Tide Water Associated Oil Company
Historian - Anna Minkofsky, Shell Oil Co., Inc.

Meets the first Friday of every month, 7:30 P.M., Civil Courts Room, Caddo Parish Court House. Special dinner meetings by announcement.

MICHIGAN

MICHIGAN GEOLOGICAL SOCIETY

President - - - - - - - - W. A. Clark
Mt. Pleasant

Vice-President - - - - - - - W. F. Brown
Mt. Pleasant

Secretary-Treasurer - - - - - C. H. Riggs
Michigan Geological Survey
21 Sheldon, N.E., Grand Rapids

Business Manager - - - - - S. G. Bergquist
Michigan State College, East Lansing

Meetings: Monthly dinner meetings rotating between Saginaw, Mt. Pleasant, and Lansing. Informal dress.

SOUTH LOUISIANA GEOLOGICAL SOCIETY
LAKE CHARLES, LOUISIANA

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Atlantic Refining Company
Vice-President - - - - - - - - - Coe Mills
Ohio Oil Company, Lafayette, Louisiana
Secretary - - - - - - - - - E. M. Baysinger
Box 210
Treasurer - - - - - - - - - - Baker Hoskins
Shell Oil Company, Inc., Box 598

Meetings: Luncheon 1st Wednesday at Noon (12:00) and business meeting third Tuesday of each month at 7.00 P.M. at the Majestic Hotel. Visiting geologists are welcome.

TEXAS

FORT WORTH GEOLOGICAL SOCIETY
FORT WORTH, TEXAS

President - - - - - - - - - Ralph S. Powell
The Texas Company, Box 1720

Vice-President - - - - - Louis H. Freedman
Snowden and McSweeney Company

Secretary-Treasurer - - - - - Vernon Lipscomb
The Pure Oil Company, Box 2107

Meetings: Luncheon at noon, Worth Hotel, every Monday. Special meetings called by executive committee. Visiting geologists are welcome to all meetings.

HOUSTON GEOLOGICAL SOCIETY
HOUSTON, TEXAS

President - - - - - - Wallace C. Thompson
General Crude Oil Company, Box 2252

Vice-President - - - - Carleton D. Speed, Jr.
Speed Oil Company

Secretary - - - - - - - - - - Olin G. Bell
Humble Oil and Refining Company, Box 2180

Treasurer - - - - - - - - - - A. P. Allison
Sun Oil Company, Box 2659

Regular meeting held every Thursday at noon (12 o'clock) above Kelly's Restaurant, 910 Texas Avenue. For any particulars pertaining to the meetings write of call the secretary.

NORTH TEXAS GEOLOGICAL SOCIETY
WICHITA FALLS, TEXAS

President - - - - - - - - - P. M. Martin
Continental Oil Company, Box 1800

Vice-President - - - - - - L. Edwin Patterson
Cities Service Oil Company

Secretary-Treasurer - - - - - R. E. McPhail
Phillips Petroleum Company

Luncheons and evening programs will be announced.

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Secretary-Treasurer - - - - Robert N. Kolm
1742 Milam Building, San Antonio

Executive Committee - - - - - - L. W. Storm

Meetings: Third Friday of each month at 8 P.M. at the Petroleum Club. Luncheons every Monday noon at Petroleum Club, Alamo National Building, San Antonio, and at Plaza Hotel, Corpus Christi.

SOUTHWESTERN GEOLOGICAL SOCIETY
AUSTIN, TEXAS

President - - - - - - - Leo Hendricks
Bureau of Economic Geology

Vice-President - - - - - - - G. M. Stafford
Univ. Texas, Dept. of Geology

Secretary-Treasurer - - - - - - S. A. Lynch
North Texas Agricultural College, Arlington, Texas

Meetings: Every third Friday at 8:00 P.M. at the University of Texas, Geology Building 14.

WEST TEXAS GEOLOGICAL SOCIETY
MIDLAND, TEXAS

President - - - - - - - John Emery Adams
Standard Oil Company of Texas, Box 1660

Vice-President - - - - - - - Dana M. Secor
Skelly Oil Company

Secretary-Treasurer - - - - - Fred F. Kotyza
Tide Water Associated Oil Company, Box 181

Meetings will be announced

WEST VIRGINIA

THE APPALACHIAN GEOLOGICAL SOCIETY
CHARLESTON, WEST VIRGINIA
P.O. Box 1435

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Vice-President - - - - - Charles Brewer, Jr.
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Secretary-Treasurer - - - - Thurman H. Myers
Carnegie Natural Gas Co., Pittsburgh, Pa.

Editor - - - - - - - - - Robert C. Lafferty
Owens, Libbey-Owens Gas Department

Meetings: Second Monday, each month, at 6:30 P.M., Kanawha Hotel.

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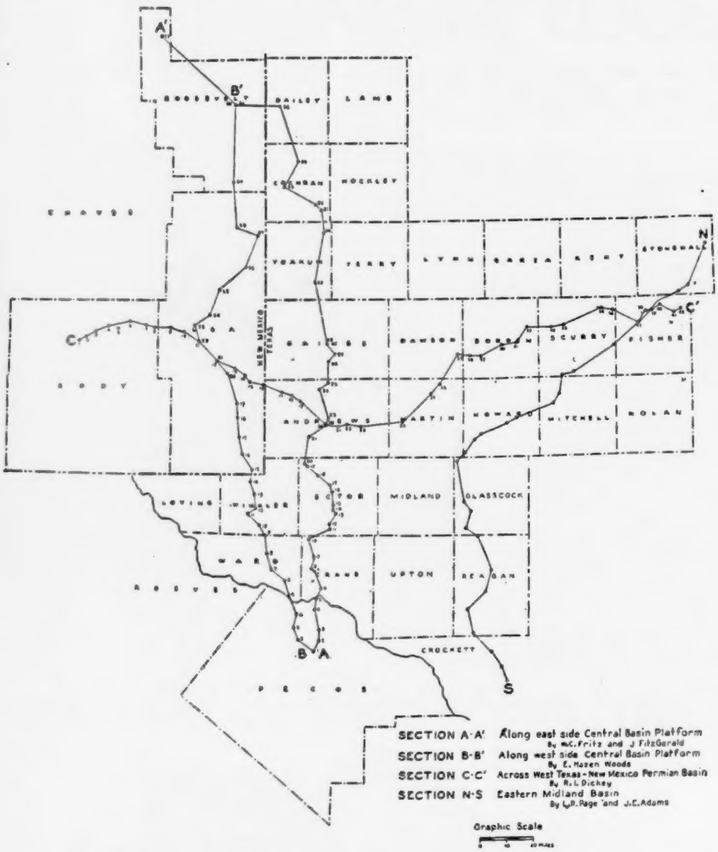
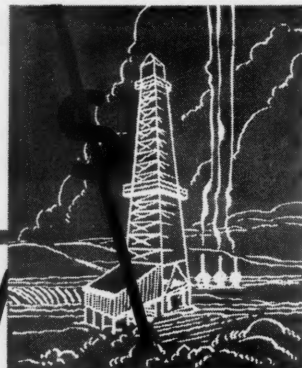


Announcement of these West Texas-New Mexico stereograms and cross sections, made in the January, 1940, Bulletin, is here repeated for those who desire to take advantage of this offer. These sections, shown only in skeleton or reduced form in the West Texas-New Mexico symposium, are available as blue-line paper prints, showing full detail.

	PRICES POSTPAID	
	A.A.P.G. & Colleges	*To Others*
LEWIS STEREOGRAMS (Jan. Bulletin p. 13). Vertical scale, 1 in. = 1,000 ft. Set of 3 sheets 72 x 42; 48 x 40; 32 x 20 in.	$3.35	$4.25
SECTION AA, (Jan. Bull. p. 16). Scale, 1 in. = 4 mi. 84 x 21 in.	1.35	1.70
SECTION BB, (Jan. Bull. p. 30). Scale, 1 in. = 4 mi. 72 x 20 in.	1.10	1.35
SECTION CC, (Jan. Bull. p. 38). Scale, 1 in. = 4 mi. 75 x 27 in.	1.40	1.80
SECTION NS, (Jan. Bull. p. 56). Scale, 1 in. = 4 mi. 36 x 24 in.	0.70	0.80

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